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NASA SPONSORED
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ACCESSION NUMBER
N91-10047*# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
CORPORATE SOURCE
TITLE
NONLINEAR FEEDBACK CONTROL FOR HIGH ALPHA FLIGHT Final Report, Jan. 1989 - Apr. 1990
PUBLICATION DATE
AUTHOR
Harold Stalford Apr. 1990 15 p
CONTRACT OR GRANT
(Grant NAG1-959)
AVAILABILITY SOURCE
REPORT NUMBERS
(NASA-CR-186545; NAS 1.26;186545) Avail: NTIS HC/MF A03
PRICE CODE
COSATI CODE
CSCL 01C
Analytical aerodynamic models are derived from a high alpha 6 DOF wind tunnel model. One detail model requires some interpolation between nonlinear functions of alpha. One analytical model requires no interpolation and as such is a completely continuous model. Flight path optimization is conducted on the basic maneuvers: half-loop, 90 degree pitch-up, and level turn. The optimal control analysis uses the derived analytical model in the equations of motion and is based on both moment and force equations. The maximum principle solution for the half-loop is poststall trajectory performing the half-loop in 13.6 seconds. The agility induced by thrust vectoring capability provided a minimum effect on reducing the maneuver time. By means of thrust vectoring control the 90 degrees pitch-up maneuver can be executed in a small place over a short time interval. The agility capability of thrust vectoring is quite beneficial for pitch-up maneuvers. The level turn results are based currently on only outer layer solutions of singular pertrubation. Poststall solutions provide high turn rates but generate higher losses of energy than that of classical sustained solutions.
Author

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01 AERONAUTICS (GENERAL)

N91-22067# Aviation Planning Associates, Inc., Cincinnati, OH.
ECONOMIC IMPACT OF AVIATION IN PENNSYLVANIA Final Report
Mar. 1990 85 p Sponsored by Pennsylvania Dept. of Transportation, Harrisburg
(PB91-128264) Avail: NTIS HC/MF A05 CSCL 01B

The output (gross sales, taxes, and capital expenditures) payroll, and employment generated by aviation activity in Pennsylvania in 1988 are identified. The Commonwealth's aviation network, which includes 146 public-use airports (17 commercial service and 129 general aviation), 350 private airports, and 300 heliports, is a major economic contributor and a simulator of business and industrial development. The direct economic contributions made by airports is identified, and also the induced impacts accrued when aviation dollars circulate throughout the economy, creating successive waves of spending, was estimated. Direct impacts were identified through data collected from major aviation-related groups. Induced impacts were estimated using economic multipliers supplied by the Pennsylvania State University. A major survey conducted for the study showed that the Commonweath's businesses and industries rely heavily on aviation services. Businesses rated the availability of airports as the third most important of 10 key site selection criteria, and 85 percent said they use commercial air service. GRA

N91-22068# Federal Aviation Administration, Washington, DC. Office of Aviation Policy and Plans.
FAA AVIATION FORECASTS: FISCAL YEARS 1991-2002
Feb. 1991 281 p
(AD-A231721; FAA-APO-91-1) Avail: NTIS HC/MF A13 CSCL 17/7

This report contains the Fiscal Years 1991-2002 Federal Aviation Administration (FAA) forecasts of aviation activity at FAA facilities. These include airports with FAA control towers, air route traffic control centers, and flight service stations. Detailed forecasts were made for the major users of the National Aviation System: air carriers, air taxi-commuters, non-military and general aviation. The forecasts have been prepared to meet the budget and planning needs of the constituent units of the FAA and to provide information that can be used by state and local authorities, the aviation industry, and the general public. After a downturn in economic growth in 1991, caused largely by an escalation in oil prices, the overall outlook for the 12-year forecast period is for contiued economic growth, declining real fuel prices, and moderate inflation. Based upon these assumptions, aviation activity by fiscal year 2002 is forecast to increase by 27.4 percent at towered airports, 30.1 percent at air route traffic control centers, and 6.5 percent in flight services performed. Hours flown by general aviation are forecast to increase 17.5 percent and domestic revenue passenger miles (RPM's) are forecast to increase 62.6 percent, with scheduled international RPM's forecast to increase by 110.8 percent and regionals/commuters RPM's forecast to increase by 140.4 percent. GRA

02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

N91-22069*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AEROPROPULSIVE CHARACTERISTICS OF CANTED TWIN PITCH-VECTORING NOZZLES AT MACH 0.20 TO 1.20
Francis J. Capone, Mary L. Mason, and George T. Carson, Jr. Washington May 1991 257 p
(NASA-TP-3060; L-16823; NAS 1.60:3060) Avail: NTIS HC/MF A12 CSCL 01A

The multiaxis thrust vectoring capability from canting 2-D convergent-divergent exhaust nozzles installed on a twin jet afterbody model was determined in an investigation conducted in the Langley 16 foot Transonic Tunnel. Pitch vectoring was accomplished by the deflection of the nozzle upper and lower divergent flaps. Several combinations of symmetric and differential pitch deflection angles were tested at nozzle cant angles of 0, 30, and 45 degrees. The effect of varying nozzle divergent flap length was also studied. Mach numbers from 0.20 to 1.20, angles of attack from 0 to 27.5 degrees nozzle pressure ratios up to 8.0, and sideslip angles of 0 to 5 degrees were the variables used. Author

N91-22070*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NUMERICAL STUDY OF THE AERODYNAMIC EFFECTS OF USING SULFUR HEXAFLUORIDE AS A TEST GAS IN WIND TUNNELS
W. Kyle Anderson Washington Jan. 1991 26 p Previously announced in IAA as A90-37958
(NASA-TP-3086; L-16849; NAS 1.60:3086) Avail: NTIS HC/MF A03 CSCL 01A

A numerical study is presented which investigates effects of using sulfur hexafluoride, SF6, as a substitute for air. Inviscid results for airfoils indicate that for transonic cases the shock location calculated for SF6 is vastly different from that in air and moves progressively forward on the airfoil as the freestream pressure is increased and real gas effects become more pronounced. Application of a simple Mach number scaling procedure results in good correlation between SF6 and air even for pressures at which non-ideal gas effects are significant. Computations for subsonic turbulent flows over a NACA 0012 airfoil show that the maximum angle of attack at which steady lift can be obtained is different between air and SF6. In addition, for SF6, this angle of attack depends greatly on the freestream conditions. Close agreement with air can be achieved by altering the freestream Mach number according to the inviscid scaling procedure. Transonic results show that even with Mach number scaling, the shock location and skin friction values calculated between air and SF6 are in disagreement. This is attributed to the limitations of the scaling procedure and to the thinner boundary layer for SF6. Author

N91-22071*# MCAT Inst., San Jose, CA.
GRID GENERATION ABOUT COMPLEX THREE-DIMENSIONAL AIRCRAFT CONFIGURATIONS Final Report
Goetz H. Klopfer Apr. 1991 16 p
(Contract NCC2-616)
(NASA-CR-188097; NAS 1.26:188097; MCAT-91-003) Avail: NTIS HC/MF A03 CSCL 01A

The problem of obtaining three dimensional grids with sufficient resolution to resolve all the flow or other physical features of interest is addressed. The generation of a computational grid involves a series of compromises to resolve several conflicting requirements. On one hand, one would like the grid to be fine enough and not too skewed to reduce the numerical errors and to adequately resolve the pertinent physical features of the flow field about the aircraft. On the other hand, the capabilities of present or even future supercomputers are finite and the number of mesh points must be limited to a reasonable number: one which is usually much less than desired for numerical accuracy. One technique to overcome this limitation is the 'zonal' grid approach. In this method, the overall field is subdivided into smaller zones or blocks in each of which an independent grid is generated with enough grid density to resolve the flow features in that zone. The zonal boundaries or interfaces require special boundary conditions such that the conservation properties of the governing equations are observed. Much work was done in 3-D zonal approaches with nonconservative zonal interfaces. A 3-D zonal conservative interfacing method that is efficient and easy to implement was developed during the past year. During the course of the work, it became apparent that it would be much more feasible to do the conservative interfacing with cell-centered finite volume codes instead of the originally planned finite difference codes. Accordingly, the CNS code was converted to finite volume form. This new version of the code is named CNSFV. The original multi-zonal interfacing capability of the CNS code was enhanced by generalizing the procedure to allow for completely arbitrarily shaped zones with no mesh continuity between the zones. While this zoning capability works well for most flow situations, it is, however, still nonconservative. The conservative interface algorithm was also implemented but was not completely validated. Author

N91-22072 Oxford Univ. (England).
APPLICATIONS OF LIQUID CRYSTALS IN AERODYNAMIC TESTING Ph.D. Thesis
Paul Bonnett 1989 225 p
Avail: Univ. Microfilms Order No. BRD-90428

The application of liquid crystals in three areas of aerodynamic testing are examined: temperature, shear stress, and pressure measurement over surfaces. The use of the selective reflection colors from encapsulated chiral nematic materials to map surface temperatures is assessed. This method is very successful in a wide range of applications for determining heat transfer rates, but has limitations where high heat transfer rates are present, due to the thermal response time of the material structure and the effects of temperature gradients. The thermal time constant is determined as a function of material viscosity. It is typically 10 ms for a chiral nematic material at room temperature. The effect of a temperature gradient on the selective reflections is studied in terms of the pitch gradient produced in the material structure. Two improved methods are then proposed. The first makes use of the cholesteric to isotropic transition to indicate an isotherm on a heated surface, while the second uses changes in the birefringence colors produced by a aligned nematic layer applied to a surface and viewed between crossed polarizers. Changes in the selective reflection colors for cholesteric liquid crystals can be used to assess surface shear stress levels. This method is assessed and determined to be too problematic for accurate measurements. A new method based on the shear induced texture change from the focal-conic to the Grandjean texture in the cholesteric phase is proposed. This method may be used to quantify surface shear stress levels as well as to provide excellent flow visualization once flow alignment has occurred. Tests were conducted on the pressure sensitivity of chiral nematic liquid crystal materials. The results indicate that the change in transition temperature with pressure is of the order of 40 degrees/kbar, which may not be sensitive for wind tunnel purposes. Dissert. Abstr.

N91-22073 Stanford Univ., CA.
ON THE SUITABILITY OF THE CONNECTION MACHINE FOR DIRECT PARTICLE SIMULATION Ph.D. Thesis
Leonardo Dagum 1990 178 p
Avail: Univ. Microfilms Order No. DA9102248

The recent resurgence of interest in rarefied gas dynamics has spawned new research activity in the field of direct particle simulation. An outcome of this activity was the Stanford particle simulation (SPS) method which was developed to make the most efficient use of supercomputer architectures. It is largely accepted that future improvements in supercomputing performance will be in the direction of increased parallelism, and massively parallel architectures represent the research frontier in this direction. The suitability of this architecture, and the Connection Machine in particular, are investigated for the direct particle simulation of rarefied gas dynamic flows. An algorithmic structure of the vectorizable SPS method is examined and the structure is reformulated in a manner suitable for data parallel implementation. Some of the SPS algorithms can be directly translated to data parallel form, but several of the vectorizable algorithms have no direct data parallel equivalent, and thus predicate the development of new, strictly data parallel algorithms. In particular, new sorting algorithms were developed to identify collision candidates in the simulation and a master/slave algorithm to minimize communication cost in large table look up. Validation of the method is undertaken through test calculations for thermal relaxation of a gas, shock wave profiles, and shock reflection from a stationary wall. In addition to these test calculations, a large scale two dimensional simulation for the flow about a double ellipse geometry is presented and compared to the results for the same calculation performed with the fully vectorized SPS method on the Cray 2. An important results is a quantitative measure of the performance of the Connection Machine for direct particle simulation. From this result it is possible to conclude that the massively parallel architecture of the Connection Machine is quite suitable for this type of calculation. Dissert. Abstr.

N91-22074 Cranfield Inst. of Tech., Bedford (England).
APPROXIMATE METHODS FOR PREDICTING THE LIFTING CHARACTERISTICS OF WING-BODY COMBINATIONS Ph.D. Thesis
Sakher Hamwi 1989 349 p
Avail: Univ. Microfilms Order No. BRDX90890

The development of the theory and program (DBVL), based on two well established analysis tools, the vortex-lattice method and axial distributions of discrete doublets, which were combined in a relatively simple way to study aerodynamic wing/body interference are described. Comparisons, for isolated bodies (blunt or pointed), isolated plate wings and wing/body combinationd, were made with exact solutions, experimental data, and some other available methods, such as the panel method (SPARV). It is concluded that the new method and its associated program are accurate, versatile, and efficient, requiring only 4 to 5 percent of the CPU time employed by SPARV when applied to examples of considerable complexity. An additional feature of these comparisons was the accuracy with which the wing-body interference factors could be predicted, particularly when compared with those based on slender-body theory. Dissert. Abstr.

N91-22075 Cranfield Inst. of Tech., Bedford (England).
HYPERSONIC FLOW OF A VIBRATIONALLY-RELAXING GAS PAST A SLIGHTLY BLUNTED SLENDER WEDGE Ph.D. Thesis
M. S. Mughal 1989 313 p
Avail: Univ. Microfilms Order No. BRDX90885

The flow of a vibrationally-relaxing gas past a blunted slender wedge in hypersonic flow is investigated using the method of matched asymptotic expansions. Of particular interest are the effects of bluntness and non-equilibrium on the asymptotic flow downstream of the subsonic portions of the body. The nose (shock)

bluntness causes the formation of a low-density, high entropy air enveloping the body which for the perfect-gas situation is known to influence significantly flowfield properties. The effects of including a chemically reacting system on the entropy-layer and its subsequent effects on flowfield properties are also investigated.
Dissert. Abstr.

N91-22076 Iowa State Univ. of Science and Technology, Ames.
ON COMPUTATIONS OF THE INTEGRATED SPACE SHUTTLE FLOWFIELD USING OVERSET GRIDS Ph.D. Thesis
Ing-Tsau Chiu 1990 154 p
Avail: Univ. Microfilms Order No. DA9101340

Numerical simulations using the thin-layer Navier-Stokes equations and chimera (overset) grid approach were carried out for flows around the integrated Space Shuttle over a range of Mach numbers. Body-conforming grids were used for all the component grids. Test cases include a three-component overset grid (the external tank (ET), the solid rocket booster (SRB), and the orbiter (ORB)) and a five component grid (the ET, SRB, ORB, and forward and aft attached hardware configurations). The results were compared with the wind tunnel and flight data. In addition, a Poisson solution procedure (a special case of the vorticity-velocity formulation) using primitive variables was developed to solve three dimensional, irrotational, inviscid flows for single as well as overset grids. The solutions were validated by comparisons with other analytical or numerical solutions, and/or experimental results for various geometries. The Poisson solution was also used as an initial guess for the thin-layer Navier-Stokes solution procedure to improve the efficiency of the numerical flow simulations. It was found that this approach resulted in roughly a 30 percent CPU time savings as compared with the procedure solving the thin-layer Navier-Stokes equations from a uniform free stream flowfield.
Dissert. Abstr.

N91-22077*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
FORCES AND PRESSURES INDUCED ON CIRCULAR PLATES BY A SINGLE LIFTING JET IN GROUND EFFECT
David C. Bellavia, Douglas A. Wardwell, Victor R. Corsiglia, and Richard E. Kuhn (STO-VL Technology, San Diego, CA.) Mar. 1991 100 p
(NASA-TM-102816; A-90142; NAS 1.15:102816) Avail: NTIS HC/MF A05 CSCL 01A

NASA Ames is conducting a program to develop improved methods for predicting suckdown and hot-gas ingestion on jet V/STOL aircraft when they are in ground effect. As part of that program a data base is being created that provides a systematic variation of parameters so that current empirical prediction procedures can be modified. The first series of tests in this program is complete. This report is one of three that presents the data obtained from tests conducted at Lockheed Aeronautical Systems - Rye Canyon Facility and the High Bay area of the 40 by 80 foot Wind Tunnel at Ames Research Center. Suckdown on two circular plates is examined.
Author

N91-22078*# Lockheed Engineering and Sciences Co., Hampton, VA.
AERODYNAMIC PARAMETER STUDIES AND SENSITIVITY ANALYSIS FOR ROTOR BLADES IN AXIAL FLIGHT
Y. Danny Chiu and David A. Peters (Georgia Inst. of Tech., Atlanta.) Mar. 1991 17 p Presented at the International Technical Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, 25-27 Mar. 1991
(Contract NAS1-19000; NAG1-710)
(NASA-CR-187524; NAS 1.26:187524) Avail: NTIS HC/MF A03 CSCL 01A

The analytical capability is offered for aerodynamic parametric studies and sensitivity analyses of rotary wings in axial flight by using a 3-D undistorted wake model in curved lifting line theory. The governing equations are solved by both the Multhopp Interpolation technique and the Vortex Lattice method. The singularity from the bound vortices is eliminated through the Hadamard's finite part concept. Good numerical agreement between both analytical methods and finite differences methods are found. Parametric studies were made to assess the effects of several shape variables on aerodynamic loads. It is found, e.g., that a rotor blade with out-of-plane and inplane curvature can theoretically increase lift in the inboard and outboard regions respectively without introducing an additional induced drag.
Author

N91-22079*# MCAT Inst., San Jose, CA.
POWER-ON PERFORMANCE PREDICTIONS FOR A COMPLETE GENERIC HYPERSONIC VEHICLE CONFIGURATION Annual Report
Bradford C. Bennett Apr. 1991 10 p Original contains color illustrations
(Contract NCC2-522)
(NASA-CR-188152; NAS 1.26:188152; MCAT-91-004) Avail: NTIS HC/MF A02; 2 functional color pages CSCL 01A

The Compressible Navier-Stokes (CNS) code was developed to compute external hypersonic flow fields. It has been applied to various hypersonic external flow applications. Here, the CNS code was modified to compute hypersonic internal flow fields. Calculations were performed on a Mach 18 sidewall compression inlet and on the Lewis Mach 5 inlet. The use of the ARC3D diagonal algorithm was evaluated for internal flows on the Mach 5 inlet flow. The initial modifications to the CNS code involved generalization of the boundary conditions and the addition of viscous terms in the second crossflow direction and modifications to the Baldwin-Lomax turbulence model for corner flows. Author

N91-22080*# Arizona State Univ., Tempe. Coll. of Engineering and Applied Sciences.
A REVIEW OF NEAR-WALL REYNOLDS-STRESS
R. M. C. So, Y. G. Lai, H. S. Zhang, and B. C. Hwang (David Taylor Research Center, Annapolis, MD.) Washington May 1991 64 p
(Grant NAG1-1080)
(NASA-CR-4369; NAS 1.26:4369) Avail: NTIS HC/MF A04 CSCL 01A

The advances made in second-order near-wall turbulence closures are summarized. All closures examined are based on some form of high Reynolds number models for the Reynolds stress and the turbulent kinetic energy dissipation rate equations. Consequently, most near-wall closures proposed to data attempt to modify the high Reynolds number models for the dissipation rate equation so that the resultant models are applicable all the way to the wall. The near-wall closures are examined for their asymptotic behavior so that they can be compared with the proper near-wall behavior of the exact equations. A comparison of the closure's performance in the calculation of a low Reynolds number plane channel flow is carried out. In addition, the closures are evaluated for their ability to predict the turbulence statistics and the limiting behavior of the structure parameters compared to direct simulation data.
Author

N91-22081# Naval Postgraduate School, Monterey, CA.
SEPARATING BOUNDARY LAYER RESPONSE TO AN UNSTEADY TURBULENT ENVIRONMENT M.S. Thesis
David J. Gwilliam, Jr. Dec. 1989 43 p
(AD-A231483) Avail: NTIS HC/MF A03 CSCL 01/1

An experimental investigation of the separating boundary layer of a wing subjected to periodic turbulent disturbances was conducted. Turbulence pulses were generated by a non-thrusting spinning rod placed upstream of the test airfoil at the reduced frequencies of .09 and .47. Time-varying velocity measurements were made at various heights above the 70 percent chord location at 12 degrees angle of attack (nearly separated flow) and 22 degrees angle of attack (fully separated flow). Split-film anemometry was used to determine flow speed and direction. The flow responses were compared to the quasi-steady state of undisturbed separated flow. Variation of reduced frequency had a dramatic influence on the effects which the periodic disturbance had on the flow response. At a reduced frequency of .47, the periodic disturbance had no noticeable influence. Imposition of periodic

disturbance of the same reduced frequency on attached flow near separation (12 degrees angle of attack) once again caused no apparent destabilizing effects. The lack of sensitivity of the separated boundary layer to the pulses generated at the higher reduced frequency of .47 apparently resulted from its inability to resolve turbulent pulses from one another. Imposition at 22 degrees angle of attack of a pulse at the reduced frequency of .09, however, first stabilized the flow, then greatly intensified the original separation before allowing the flow to return to its undisturbed separated state. GRA

N91-22082# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Engineering Science and Mechanics.
THE TRANSIENT DEVELOPMENT OF VORTICES OVER A DELTA WING Final Report, 1 Mar. 1989 - 30 Sep. 1990
Demetri P. Telionis 23 Dec. 1990 9 p
(Grant AF-AFOSR-0283-89; AF Proj. 2307)
(AD-A231946; AFOSR-91-0026TR) Avail: NTIS HC/MF A02 CSCL 01/1

The most interesting finding was that for large angles of attack, a delta wing actually sheds vortices alternately, just like bluff bodies do. Also, at high sweep angles, vortex shedding is suddenly initiated at an angle of attack of 37 degrees. In addition, it was found that a seven-hole probe as small in diameter as 2 pct. of the diameter of the vortex can actually precipitate breakdown, but with little effect on the static pressure on the wing suction surface. GRA

N91-22083*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
MULTIAXIS THRUST VECTORING USING AXISYMMETRIC NOZZLES AND POSTEXIT VANES ON AN F/A-18 CONFIGURATION VEHICLE
Albion H. Bowers, Gregory K. Noffz, Sue B. Grafton, Mary L. Mason, and Lee R. Peron (California Polytechnic State Univ., San Luis Obispo.) Apr. 1991 36 p Presented at the High-Angle-of Attack Technology Conference, Hampton, VA, 30 Oct. - 1 Nov. 1990
(NASA-TM-101741; H-1705; NAS 1.15:101741) Avail: NTIS HC/MF A03 CSCL 01A

A ground-based investigation was conducted on an operational system of multiaxis thrust vectoring using postexit vanes around an axisymmetric nozzle. This thrust vectoring system will be tested on the NASA F/A-18 High Alpha Research Vehicle (HARV) aircraft. The system provides thrust vectoring capability in both pitch and yaw. Ground based data were gathered from two separate tests at NASA Langley Research Center. The first was a static test in the 16-foot Transonic Tunnel Cold-Jet Facility with a 14.25 percent scale model of the axisymmetric nozzle and the postexit vanes. The second test was conducted in the 30 by 60 foot wind tunnel with a 16 percent F/A-18 complete configuration model. Data from the two sets are being used to develop models of jet plume deflection and thrust loss as a function of vane deflection. In addition, an aerodynamic interaction model based on plume deflection angles will be developed. Results from the scale model nozzle test showed that increased vane deflection caused exhaust plume turning. Aerodynamic interaction effects consisted primarily of favorable interaction of moments and unfavorable interaction of forces caused by the vectored jet plume. Author

N91-22084*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NUMERICAL FLUX FORMULAS FOR THE EULER AND NAVIER-STOKES EQUATIONS. 2: PROGRESS IN FLUX-VECTOR SPLITTING
William J. Coirier and Bram VanLeer (Michigan Univ., Ann Arbor.) 1991 19 p Presented at the 10th Computational Fluid Dynamics Conference, Honolulu, HI, 24-27 Jun. 1991; sponsored by AIAA
(NASA-TM-104353; E-6138; NAS 1.15:104353; AIAA-91-1566) Avail: NTIS HC/MF A03 CSCL 01A

The accuracy of various numerical flux functions for the inviscid fluxes when used for Navier-Stokes computations is studied. The flux functions are benchmarked for solutions of the viscous, hypersonic flow past a 10 degree cone at zero angle of attack using first order, upwind spatial differencing. The Harten-Lax/Roe flux is found to give a good boundary layer representation, although its robustness is an issue. Some hybrid flux formulas, where the concepts of flux-vector and flux-difference splitting are combined, are shown to give unsatisfactory pressure distributions; there is still room for improvement. Investigations of low diffusion, pure flux-vector splittings indicate that a pure flux-vector splitting can be developed that eliminates spurious diffusion across the boundary layer. The resulting first-order scheme is marginally stable and not monotone. Author

N91-22085*# Analytical Services and Materials, Inc., Hampton, VA.
NONPARALLEL INSTABILITY OF SUPERSONIC AND HYPERSONIC BOUNDARY LAYERS Final Report
Nabil M. El-Hady Washington May 1991 59 p Previously announced in IAA as A91-21461
(Contract NAS1-18599)
(NASA-CR-4373; NAS 1.26:4373) Avail: NTIS HC/MF A04 CSCL 01A

Multiple scaling technique is used to examine the nonparallel instability of supersonic and hypersonic boundary-layer flows to three dimensional (first mode) and two dimensional (second mode) disturbances. The method is applied to the flat plate boundary layer for a range of Mach numbers from 0 to 10. Growth rates of disturbances are calculated based on three different criteria: following the maximum of the mass-flow disturbance, using an integral of the disturbance kinetic energy, and using the integral of the square of the mass-flow amplitude. By following the maximum of the mass-flow disturbance, the calculated nonparallel growth rates are in good quantitative agreement with the experimental results at Mach number 4.5. Author

N91-22086# Bristol Univ. (England). Dept. of Aerospace Engineering.
EFFECT OF PLANFORM ON INDUCED DRAG B.S. Thesis
J. P. Darcy and D. A. Parkin-Moore Jun. 1990 46 p
(BU-500; ETN-91-99193) Avail: NTIS HC/MF A03

A baseline, elliptical wing with a straight line quarter chord was tested and results compared with a crescent moon shaped planform wing with the same Clark-Y section, chord distribution and aspect ratio of 4.5. The provision of flow visualization photographs assisted in the qualitative assessment of the results and facilitated the analysis of planforms effects on the flow. Induced drag factors of near and below unity were calculated for both wings, which were tested at Reynolds numbers of between 0.40 and 0.55 million. The baseline wing had an induced drag factor of 0.935 compared to the larger induced drag factor of the crescent wing of 0.953. ESA

N91-22087# Bristol Univ. (England). Dept. of Aerospace Engineering.
A LEADING-EDGE CONTROL SURFACE B.S. Thesis
S. R. B. Lees and U. Periyathamby Jun. 1990 105 p
(BU-508; ETN-91-99201) Avail: NTIS HC/MF A06

The effects of a simply hinged leading edge control device was investigated with regard to supression of flutter at high angles of attack. At high angles of attack the rotation of the trailing and leading edge devices independently and simultaneously were studied, using flow visualization to determine the range of deflections in which they can have a beneficial effect on the flow and consequently on changes in lift, drag, etc. These are compared with results from another model with identical section, which has well known pressure distributions and well known aerodynamic coefficients from the integration of these pressure distributions. The investigation shows that at high angles of attack a stalled airflow can be recovered in the static case using the leading edge device. However, it is difficult to predict whether very rapid movement of these surfaces would also produce attractive lift coefficients when the motion itself could cause the airflow to become stalled or at least temporarily separated. ESA

N91-22088# Bristol Univ. (England). Dept. of Aerospace Engineering.
FLOW AROUND A STORE-PYLON COMBINATION IN A CURVED FLOW FIELD B.S. Thesis
K. P. Nicholl and A. J. Seaman Jun. 1990 96 p
(BU-514; ETN-91-99207) Avail: NTIS HC/MF A05

When a slender cylinder ogive body, representing an aircraft store, mounted on a pylon, is placed in a fluid flow at non zero incidence, trailing vortices are produced which become more significant as the incidence is increased. When the flow encounters a junction such as exists between the store body and pylon, further vortices are generated. The interaction of vortices generated by a simulated store pylon combination is investigated qualitatively. To represent conditions close to a combat aircraft, effects of flow field curvature were considered. The investigation was carried out in various low speed wind tunnels and made use of flow visualization techniques including oil surface flow, smoke and wool tufts. Vortices were observed separating from the body at various positions, dependent on pitch and yaw angles. The effect of the pylon depended on whether the incidence was positive or negative. At positive incidences the body vortex paths interfered with the flow over the pylon whereas at negative incidences vortex growth was restricted on the leeward side. ESA

N91-22089# Bristol Univ. (England). Dept. of Aerospace Engineering.
AN INVESTIGATION INTO THE EXTENT AND EFFECTS OF SPANWISE FLOW IN THE BOUNDARY LAYER OF A HELICOPTER ROTOR IN HOVER B.S. Thesis
R. G. Taylor-Hunt and J. P. Winter Jun. 1990 54 p
(BU-519; ETN-91-99212) Avail: NTIS HC/MF A04

Results are presented for an investigation into the spanwise component of flow which is purported to exist in the boundary layer of a helicopter rotor. A model rotor of 1.6 m diameter was tested in the hovering condition, using 'microtufts' and the China clay method in order to study the boundary layer flow. The flow visualization techniques were developed with considerable success, and it was shown that the extent of signficant spanwise flow is small. The spanwise flow which did exist in a separation bubble was prevented by chordwise fences as a control, and numerical results did not measure any stall delaying effects associated with the weak spanwise flow. ESA

N91-22090*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DEVELOPMENT OF A GRID-INDEPENDENT APPROXIMATE RIEMANNSOLVER Ph.D. Thesis - Michigan Univ.
Christopher Lockwood Rumsey 1991 246 p
(NASA-TM-104946; NAS 1.15:104946) Avail: NTIS HC/MF A11 CSCL 01A

A grid-independent approximate Riemann solver for use with the Euler and Navier-Stokes equations was introduced and explored. The two-dimensional Euler and Navier-Stokes equations are described in Cartesian and generalized coordinates, as well as the traveling wave form of the Euler equations. The spatial and temporal discretization are described for both explicit and implicit time-marching schemes. The grid-aligned flux function of Roe is outlined, while the 5-wave grid-independent flux function is derived. The stability and monotonicity analysis of the 5-wave model are presented. Two-dimensional results are provided and extended to three dimensions. The corresponding results are presented. B.G.

N91-22091*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SMALL-SCALE EXPERIMENTS IN STOVL GROUND EFFECTS
Victor R. Corsiglia, Douglas A. Wardwell, and Richard E. Kuhn (Kuhn, Richard E., San Diego, CA) Apr. 1991 16 p Presented at the RAS International Powered Life Conference, London, England, Aug. 1990 Previously announced in IAA as A91-21256
(NASA-TM-102813; A-90137; NAS 1.15:102813) Avail: NTIS HC/MF A03 CSCL 01A

A series of tests was completed in which suckdown and fountain forces and pressures were measured on circular plates and twin-tandem-jet generic STOVL (short takeoff and vertical landing) configurations. The tests were conducted using a small-scale hover rig, for jet pressure ratios up to 6 and jet temperatures up to 700 F. The measured suckdown force on a circular plate with a central jet was greater than that found with a commonly used empirical prediction method. The present data showed better agreement with other sets of data. The tests of the generic STOVL configurations were conducted to provide force and pressure data with a parametric variation of parameters so that an empirical prediction method could be developed. The effects of jet pressure ratio and temperature were found to be small. Lift improvement devices were shown to substantially reduce the net suckdown forces. Author

N91-22092*# Kansas Univ. Center for Research, Inc., Lawrence.
AERODYNAMICS OF THRUST VECTORING BY NAVIER-STOKES SOLUTIONS Final Report
Jing-Biau Tseng and C. Edward Lan Feb. 1991 109 p
(Grant NAG1-837)
(NASA-CR-188186; NAS 1.26:188186) Avail: NTIS HC/MF A06 CSCL 01A

Induced aerodynamics from thrust vectoring are investigated by a computational fluid dynamic method. A thin-layer Reynolds-averaged Navier-Stokes code with multiblock capability is used. Jet properties are specified on the nozzle exit plane to simulate the jet momentum. Results for a rectangular jet in a cross flow are compared with data to verify the code. Further verification of the calculation is made by comparing the numerical results with transonic data for a wing-body combination. Additional calculations were performed to elucidate the following thrust vectoring effects: the thrust vectoring effect on shock and expansion waves, induced effects on nearby surfaces, and the thrust vectoring effect on the leading edge vortex. Author

N91-22093*# Polytechnic Inst. of New York, Brooklyn. Dept. of Aerospace Engineering.
DEVELOPMENT OF A COMPUTER TECHNIQUE FOR THE PREDICTION OF TRANSPORT AIRCRAFT FLIGHT PROFILE SONIC BOOM SIGNATURES M.S. Thesis
Peter G. Coen Mar. 1991 139 p Sponsored by NASA, Washington
(NASA-CR-188117; NAS 1.26:188117) Avail: NTIS HC/MF A07 CSCL 01A

A new computer technique for the analysis of transport aircraft sonic boom signature characteristics was developed. This new technique, based on linear theory methods, combines the previously separate equivalent area and F function development with a signature propagation method using a single geometry description. The new technique was implemented in a stand-alone computer program and was incorporated into an aircraft performance analysis program. Through these implementations, both configuration designers and performance analysts are given new capabilities to rapidly analyze an aircraft's sonic boom characteristics throughout the flight envelope. Author

N91-22094# Sandia National Labs., Albuquerque, NM.
AN INTRODUCTION TO TESTING PARACHUTES IN WIND TUNNELS
J. Macha 1991 11 p Presented at the 11th AIAA Aerodynamic Decelerator Systems Technology Conference, San Diego, 9-11 Apr. 1991
(Contract DE-AC04-76DP-00789)
(DE91-009166; SAND-91-0531C; AIAA-91-0858; CONF-9104171-6) Avail: NTIS HC/MF A03

This paper reviews some of the technical considerations and current practices for testing parachutes in conventional wind tunnels. Special challenges to the experimentalist caused by the fabric construction, flexible geometry, and buff shape of parachutes are discussed. In particular, the topics of measurement technique, similarity considerations, and wall interference are addressed in a summary manner. Many references are cited which provide detailed

coverage of the state of the art in testing methods. From the discussions presented, it is obvious that there are some serious problems with state of the art methods, especially in the area of canopy instrumentation and when working with reduced-scale models. But if the experimentalist is informed about the relative importance of the various factors for a specific test objective, it is usually possible to design a test that will yield meaningful results. The lower cost and the more favorable measurement environment of wind tunnels make their use an attractive alternative to flight testing whenever possible. DOE

N91-22095*# Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.
NUMERICAL SIMULATION OF SWEPT-WING FLOWS Progress Report
Helen L. Reed Feb. 1991 55 p
(Grant NAG1-1158)
(NASA-CR-188201; NAS 1.26:188201) Avail: NTIS HC/MF A04 CSCL 01A

The transition process characteristics of flows over swept wings were computationally modelled. The crossflow instability and crossflow/T-S wave interaction are analyzed through the numerical solution of the full three dimensional Navier-Stokes equations including unsteadiness, curvature, and sweep. The leading-edge region of a swept wing is considered in a three-dimensional spatial simulation with random disturbances as the initial conditions. Author

N91-22105# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
UNSTEADY AERODYNAMICS OF SLENDER WINGS
Robert C. Nelson *In* AGARD, Special Course on Aircraft Dynamics at High Angles of Attack: Experiments and Modelling Mar. 1991 26 p (For primary document see N91-22104 14-05)
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N91-22108# National Research Council of Canada, Ottawa (Ontario).
LARGE AMPLITUDE OSCILLATIONS
E. S. Hanff *In* AGARD, Special Course on Aircraft Dynamics at High Angles of Attack: Experiments and Modelling Mar. 1991 19 p (For primary document see N91-22104 14-05)
Copyright Avail: NTIS HC/MF A07; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

N91-22109# Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.
OSCILLATORY DATA FOR TYPICAL CONFIGURATIONS
C. O. OLeary *In* AGARD, Special Course on Aircraft Dynamics at High Angles of Attack: Experiments and Modelling Mar. 1991 18 p (For primary document see N91-22104 14-05)
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03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation.*

N91-22096*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLIGHT TEST TO DETERMINE FEASIBILITY OF A PROPOSED AIRBORNE WAKE VORTEX DETECTION CONCEPT Report, Jul. 1989 - Feb. 1990
James R. Branstetter, E. C. Hastings, Jr., and James C. Patterson, Jr. (Vigyan Research Associates, Inc., Hampton, VA.) Apr. 1991 41 p Prepared in cooperation with FAA, Washington, DC
(NASA-TM-102672; NAS 1.15:102672; DOT/FAA/CT-TN90/25; ACD-20) Avail: NTIS HC/MF A03 CSCL 01C

This investigation was conducted to determine the radial extent at which aircraft mounted flow vanes or roll rate gyros can sense the circulatory flow field that exists around the lift induced vortex system generated by an aircraft in flight. The probe aircraft was equipped with wingtip sensors for measuring angle of attack and angle of sideslip, and with a fuselage mounted gyroscope for measuring roll rate. Analysis of flight test data indicated that the vortex was detectable at a lateral distance of about 105 feet (best results) using unsophisticated equipment. Measurements were made from the centerline of the probe aircraft to the center of the nearest vortex with the probe aircraft flying between one half and one and one half miles behind the vortex generating aircraft. Author

N91-22097# Materials Research Labs., Ascot Vale (Australia).
PROPOSED PREPARATIVE TECHNIQUES FOR MANUFACTURE OF MARINE DYE MARKER
R. J. Swinton and R. Gray Apr. 1991 17 p Original contains color illustrations
(MRL-TN-583; AR-006-337) Avail: NTIS HC/MF A03

A marine dye marker was developed. The laboratory scale manufacture is reviewed and its shortcomings are discussed. Techniques for large scale production are investigated and two are found to be suitable. These are based on pelletizing and granulating technology and both require slight changes to the original formulation. Author

N91-22098# Wichita State Univ., KS. National Inst. for Aviation Research.
AIRLINE QUALITY RATING
Brent D. Bowen, Dean E. Headley, and Jacqueline R. Luedtke Apr. 1991 128 p
(NIAR-91-11) Avail: NTIS HC/MF A07

An Airline Quality Rating (AQR) scale is proposed that assesses the quality of the U.S. major airlines using comparable, objective, quantifiable, periodically published data that addresses customer satisfaction concerns. This data is not consumer opinion based, but has distinct performance characteristics that are specifically attuned to the consumers point of view. The AQR focuses on quantitative factors in order to provide a more reliable and objective result in assessing service quality levels across all major domestic airlines. The combining of quantifiable and readily available data provides an objective starting point for monitoring the quality of service an individual airline might be providing. Author

N91-22099# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Aerospace Medical Panel.
THE HUMAN FACTORS RELATING TO ESCAPE AND SURVIVAL FROM HELICOPTERS DITCHING IN WATER
C. J. Brooks (Defence and Civil Inst. of Environmental Medicine, Downsview, Ontario) Feb. 1991 125 p In FRENCH English language document was announced as N90-13358
(AGARD-AG-305(F); ISBN-92-835-2116-1) Copyright Avail: NTIS HC/MF A06; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The worldwide incidence of military and civilian over-water helicopter accidents and the problems related to survival are described. Typical accident scenarios are reviewed from the moment the occupant steps onboard a helicopter to the pre-flight briefing through to the accident itself, to the difficulties with escape (commonly from underwater and in darkness), to the rescue and return safely to dry land. Improvements to crashiworthiness and life support equipment in current in-servive and future helicopters are proposed. A syllabus for underwater escape training is also discussed. Author

N91-23052*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
LIGHTWEIGHT, FIRE-RETARDANT, CRASHWORTHY AIRCRAFT SEAT CUSHIONING
Leonard A. Haslim and Paul T. McDonough *In* National Aeronautics and Space Administration, Technology 2000, Volume

1 Mar. 1991 p 254-259 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 01C

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Space Communications, Spacecraft Communications, Command and Tracking* and *Communications and Radar.*

N91-22100# Federal Aviation Administration, Atlantic City, NJ.
FLIGHT SERVICE AUTOMATION SYSTEM (FSAS) MODEL 1 FULL CAPACITY (M1FC) OPERATIONAL TEST AND EVALUATION (OT/E)/INTEGRATION TEST REPORT
Frances Mackuse, William Benner, and Robert F. Havel (Alabama Univ., Huntsville.) Apr. 1991 34 p
(DOT/FAA/CT-TN90/45) Avail: NTIS HC/MF A03

The Operational Test and Evaluation (OT&E)/Integration Test of the Flight Service Automation System (FSAS), Model 1 Full Capacity (M1FC) was conducted at the Federal Aviation Administration Technical Center, July 23-27, 1991. The FSAS M1FC consists of three subsystems: the Aviation Weather Processor (AWP); the Flight Service Data Processing System (FSDPS); and the Automated Flight Service Station (AFSS). The purpose of this testing was to verify National Airspace System (NAS) integration requirements of the subsystems and the operational effectiveness of the M1FC in meeting OT&E/integration test requirements. It was concluded that the M1FC system requires corrections and/or modifications to satisfactorily meet integration and operational requirements for effective performance in the NAS environment. Based on these conclusions, it was recommended that the deficiencies be corrected and the M1FC system be successfully retested prior to deployment. Author

N91-22101# Federal Aviation Administration, Atlantic City, NJ. Concepts Analysis Div.
AIR TRAFFIC CONTROL MEMORY: A FIELD SURVEY Technical Report, Jan. 1990 - Jan. 1991
Earl S. Stein Mar. 1991 57 p
(DOT/FAA/CT-TN90/60) Avail: NTIS HC/MF A04

This study had two goals. First was the need to evaluate the Controller Memory Handbook using input from current field controllers. The second goal was to gather data from field facilities concerning the impact of memory on the performance of controllers and how they went about trying to manage their memory resources in daily operations. Controllers agreed that memory was an important element in their work. They were able to rate it independently of their evaluation of the Handbook. The majority of the respondents liked the Handbook and saw it as a positive contribution. Most controllers suggested that effective memory management involved practicing what they were taught and using the tools provided in a consistant and conscientious manner. Author

N91-22102*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS): COCKPIT DISPLAY OF TRAFFIC INFORMATION (CDTI) INVESTIGATION. PHASE 1: FEASIBILITY STUDY TCAS-CDTI Report, Feb. - Jun. 1990
Malcolm Burgess, Dean Davis, Walter Hollister, and John A. Sorensen Apr. 1991 92 p Sponsored in part by AF
(Contract F19628-85-C-0002)
(NASA-TM-104956; NAS 1.15:104956; DOT/FAA/RD-91/8)
Avail: NTIS HC/MF A05 CSCL 17G

The possibility of the Threat Alert and Collision Avoidance System (TCAS) traffic sensor and display being used for meaningful Cockpit Display of Traffic Information (CDTI) applications has resulted in the Federal Aviation Administration initiating a project to establish the technical and operational requirements to realize this potential. Phase 1 of the project is presented here. Phase 1 was organized to define specific CDTI applications for the terminal area, to determine what has already been learned about CDTI technology relevant to these applications, and to define the engineering required to supply the remaining TCAS-CDTI technology for capacity benefit realization. The CDTI applications examined have been limited to those appropriate to the final approach and departure phases of flight. Author

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics.* For land transportation vehicles see *85 Urban Technology and Transportation.*

N91-22103*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPUTER PROGRAM FOR ESTIMATING PERFORMANCE OF AIR-BREATHING AIRCRAFT ENGINES
Karl A. Geiselhart, Michael J. Caddy (Naval Air Development Center, Warminster, PA.), and Shelby J. Morris, Jr. Washington May 1991 132 p
(NASA-TM-4254; L-16765; NAS 1.15:4254) Avail: NTIS HC/MF A07 CSCL 01C

QNEP is a reliable, easy to use computer program for predicting the design point and off-design steady state performance for a variety of airbreathing aircraft engines. These include gas turbines with single or multiple spools, multiple flow paths, and multiple exhaust nozzles, as well as, ramjets. QNEP is a modified version of the Navy Engine Performance Computer Program (NEPCOMP). NEPCOMP and its successor, the Navy NASA Engine Program (NNEP), have broad capabilities including optimization and chemical equilibrium gas computers memory requirements. QNEP was developed to be used for conceptual and preliminary design studies where the broad capability, the attendant complexity, and large memory are not necessary. QNEP is small enough to be run on a personal computers with 640 kilobytes of memory. It first sizes the engine for a selected design point where off-design performance data are to be computed. QNEP is shown to reliably compute performance parameters which agree with existing data for a variety of engines. A companion preprocessor program called QDATGEN was developed to aid inexperienced users of QNEP. It is used to interactively generate input files. QDATGEN contains a data base of seven engine configurations from which the user can choose. It includes two unducted turbofans, two ducted turbofans, two turbojets, and a ramjet. The user can also enter a new configuration or modify an existing configuration. The small size of QNEP should appeal to a wide range of users, including small companies or research organizations and especially students. It has the potential to be directly linked to other computer programs (i.e., mission weight, cost, or noise analyses) that require propulsion performance data or aircraft engine thermodynamic cycle data. A detailed description is given of QNEP including its input, accuracy, reliability, and limitations. A description is also presented of QDATGEN, sample calculations, and a user's guide. Author

N91-22104# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.
SPECIAL COURSE ON AIRCRAFT DYNAMICS AT HIGH ANGLES OF ATTACK: EXPERIMENTS AND MODELLING
Mar. 1991 144 p Special course held in Hampton, VA, 8-11 Apr. 1991 and in Rhode-Saint-Genese, Belgium, 22-25 Apr. 1991; sponsored by AGARD and the von Karman Inst.
(AGARD-R-776; ISBN-92-835-0607-3) Copyright Avail: NTIS HC/MF A07; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Lecture notes for an AGARD Fluid Dynamic Panel Special

Course on 'Aircraft Dynamics at High Angles of Attack: Experiments and Modelling' are presented. These notes present the latest information on the development and use of dynamic experiments in wind tunnels from several NATO nations. Current oscillatory and rotary test techniques, experimental results for typical configurations, and the use of these data for flight mechanics applications are addressed. Subjects include dynamic lift, wing rock, fluid dynamics of rotary flows, mathematical modelling, nonlinear data representation, vortex manipulation for control enhancement, and correlations of predictions based on rotary and oscillatory wind tunnel and flight test results. For individual titles, see N91-22105 through N91-22110.

N91-22105# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
UNSTEADY AERODYNAMICS OF SLENDER WINGS **c02**
Robert C. Nelson *In* AGARD, Special Course on Aircraft Dynamics at High Angles of Attack: Experiments and Modelling Mar. 1991 26 p (For primary document see N91-22104 14-05)
Copyright Avail: NTIS HC/MF A07; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

A review of unsteady aerodynamics for slender wings undergoing large amplitude motions is presented. Static and unsteady aerodynamics characteristics are discussed, and the relationship between the aerodynamic loads and the leeward structure is investigated. Data is presented showing the influence of the wing motion on the aerodynamic loads. Both large amplitude pitching and rolling motion experimental results are discussed. In the case of large amplitude pitching motions, significant aerodynamic hysteresis is apparent. The hysteresis in the aerodynamic loads is shown to be related to the delay in vortex breakdown on the upstroke and the delay in the re-establishment of the leading edge vortical flow after complete flow separation on the downstroke. A second example of unsteady aerodynamics, namely the phenomenon of wing rock, is examined. Author

N91-22106*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DYNAMIC STALL EFFECTS AND APPLICATIONS TO HIGH PERFORMANCE AIRCRAFT
Jay M. Brandon *In* AGARD, Special Course on Aircraft Dynamics at High Angles of Attack: Experiments and Modelling Mar. 1991 15 p (For primary document see N91-22104 14-05)
Copyright Avail: NTIS HC/MF A07; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive CSCL 01C

Recent research conducted at the NASA Langley Research Center on the effects of large amplitude pitching motions on the aerodynamic characteristics of modern fighter aircraft configurations is highlighted. Wind tunnel tests were conducted on simple flat-plate wings to gain understanding of the complex flow phenomena during unsteady motions at high angles of attack. Studies then progressed to a representative modern fighter configuration. Using a computer controlled dynamic apparatus, tests were conducted to investigate effects of pitch rate and motion time history and to determine the persistence of unsteady effects. Data were also obtained in sideslip and with control surface deflections to investigate dynamic effects on lateral stability and available control power. Force and moment data were obtained using a 6-component internal strain-gage balance. To aid in the interpretation of the results, flow visualization using a laser light-sheet system was also obtained. Results of these tests are discussed, along with their implications on the maneuverability of future advanced airplanes designed to operate in the highly dynamic, high angle-of-attack environment. Author

N91-22107# National Research Council of Canada, Ottawa (Ontario).
OSCILLATORY TEST TECHNIQUES **c08**
E. S. Hanff and C. O. OLeary (Royal Aircraft Establishment, Bedford, England) *In* AGARD, Special Course on Aircraft Dynamics at High Angles of Attack: Experiments and Modelling Mar. 1991 12 p (For primary document see N91-22104 14-05)
Copyright Avail: NTIS HC/MF A07; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

A small-amplitude oscillatory wind tunnel test technique and some small amplitude oscillatory rigs for the measurement of stability derivatives are discussed. The concentration here is on the forced-oscillation technique which is commonly used to obtain stability data. One degree of freedom oscillatory rigs and a recently developed pitch/yaw rig are described as well as the data reduction procedures used to obtain the pertinent stability derivatives. Author

N91-22108# National Research Council of Canada, Ottawa (Ontario).
LARGE AMPLITUDE OSCILLATIONS **c02**
E. S. Hanff *In* AGARD, Special Course on Aircraft Dynamics at High Angles of Attack: Experiments and Modelling Mar. 1991 19 p (For primary document see N91-22104 14-05)
Copyright Avail: NTIS HC/MF A07; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Over the past several years a consensus has been developing that the locally linear analysis technique is inadequate for the prediction of aircraft behavior in the nonlinear regime. This situation arises mainly in flight at high angles of attack, particularly during large-amplitude and high-rate maneuvers, where the flow may be severely separated, vortex dominated, and time dependent. In recognition of this situation, work is currently underway to develop techniques that can provide a better physical understanding and more accurate prediction capabilities of aircraft behavior in this regime. Much of the effort is of a rather theoretical nature, essentially consisting of a attempt to identify and implement a mathematical formalism capable of handling the various types of nonlinearities present under the above conditions. Presented here is a more empirical formulation for the treatment of aerodynamic nonlinearities and time dependence, which is based on a knowledge of the instantaneous values of the pertinent motion variables. A wind tunnel technique and rig used at the Institute for Aeronautical Research (IAR) to obtain the necessary data is described as well as some interesting results. A brief review of work involving large amplitude oscillations being conducted at the Royal Aircraft Establishment (RAE) is also included. Author

N91-22109# Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.
OSCILLATORY DATA FOR TYPICAL CONFIGURATIONS **c02**
C. O. OLeary *In* AGARD, Special Course on Aircraft Dynamics at High Angles of Attack: Experiments and Modelling Mar. 1991 18 p (For primary document see N91-22104 14-05)
Copyright Avail: NTIS HC/MF A07; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Since the early 1950's many aircraft configurations, nearly all military, have been tested on a variety of oscillatory rigs. There is a need for reliable test data on new configurations prior to flight testing and for general research on dynamic flight characteristics of combat aircraft. Examples of published test data on small amplitude oscillatory derivatives from three research centers are presented in order to give some insight into the effects of configuration, model attitude, frequency parameter, etc. on the stability derivatives. Data is given on the effect of a wing planform on a fighter configuration; forced oscillation; the effects of canards, tails, and fuselage strakes on a three-surface configuration; and subsonic roll oscillation tests on the standard dynamics model. Author

N91-22110# Eidetics International, Inc., Torrance, CA.
FOREBODY VORTEX CONTROL
Gerald N. Malcolm *In* AGARD, Special Course on Aircraft Dynamics at High Angles of Attack: Experiments and Modelling Mar. 1991 40 p (For primary document see N91-22104 14-05)
Copyright Avail: NTIS HC/MF A07; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Because conventional fighter aircraft control surfaces (e.g.

rudder) become ineffective at high angles of attack, alternate means of providing aerodynamic control are being explored. A prime potential source for improved control power is the vortex flowfield existing on typical fighter aircraft forebodies. Several techniques to manipulate the forebody vortices to produce controlled forces and moments at high angles of attack have been investigated by a number of researchers in the past few years. Some of the research results and the merits of several methods applied directly to the forebody are discussed. These methods include movable strakes, blowing surface jets, blowing and suction through surface slots, suction through surface holes, and miniaturized rotatable tip strakes. All of these were found to be effective over a varying range of angles of attack and sideslip. Most of the methods work on the basis of boundary layer separation control. The presence of closely spaced forebody vortices enhances the effectiveness, since controlling the separation controls the vortices which, in turn, creates large changes in forebody forces. Regardless of which method is employed, the maximum effectiveness is realized if it is applied near the forebody tip. The advantage of one method over another will depend on the configuration and specific performance requirements. Author

N91-22111*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
DETERMINATION OF THE EFFECTS OF HEATING ON MODAL CHARACTERISTICS OF AN ALUMINUM PLATE WITH APPLICATION TO HYPERSONIC VEHICLES
H. Todd Snyder (Planning Research Corp., Edwards, CA.) and Michael W. Kehoe Washington Apr. 1991 28 p
(NASA-TM-4274; H-1688; NAS 1.15:4274) Avail: NTIS HC/MF A03 CSCL 01C

The structural integrity of proposed high speed aircraft can be seriously affected by the extremely high surface temperatures and large temperature gradients throughout the vehicle's structure. Variations in the structure's elastic characteristics as a result of thermal effects can be seen by changes in vibration characteristics. Analysis codes that predict these changes must be correlated and verified with experimental data. Analytical and experimental modal test results are given from uniform, nonuniform, and transient thermoelastic vibration tests of a 12 x 50 x 0.19 aluminum plate. The data show the effect of heat on the modal characteristics of the plate. The results showed that frequencies decreased, damping increased, and mode shapes remained unchanged as the temperature of the plate increased. Analytical predictions provided good correlation with experimental results. Author

N91-22112 Cranfield Inst. of Tech., Bedford (England).
VARIABLE CAMBER WINGS FOR TRANSPORT AIRCRAFT Ph.D. Thesis
A. J. Rao 1989 257 p
Avail: Univ. Microfilms Order No. BRDX90881

A variable camber system was designed which ensured that the airfoil profile remained smooth and continuous throughout the range of camber shapes without requiring the use of flexible surfaces. It was made up of a fixed centre section with modified leading and trailing edge devices designed such that their deployment caused a simultaneous rotational and translational movement. A series of 2D tests were carried out to investigate the characteristics of this variable camber airfoil design. The effect of distribution of variable section camber across the span of a transport aircraft wing was investigated using a 30 deg swept, untapered half-wing model. An initial investigation of incorporating this proposed variable camber design into a medium haul transport aircraft suggested that, even allowing for an increase in the mechanism weight of the variable camber devices themselves, a wing weight saving of 10 percent could be achieved compared with the conventional aircraft design. Dissert. Abstr.

N91-22113*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RECENT ADVANCES IN APPROXIMATION CONCEPTS FOR OPTIMUM STRUCTURAL DESIGN
Jean-Francois M. Barthelemy and Raphael T. Haftka (Virginia Polytechnic Inst. and State Univ., Blacksburg.) Mar. 1991 25 p
(NASA-TM-104032; NAS 1.15:104032) Avail: NTIS HC/MF A03 CSCL 01C

The basic approximation concepts used in structural optimization are reviewed. Some of the most recent developments in that area since the introduction of the concept in the mid-seventies are discussed. The paper distinguishes between local, medium-range, and global approximations; it covers functions approximations and problem approximations. It shows that, although the lack of comparative data established on reference test cases prevents an accurate assessment, there have been significant improvements. The largest number of developments have been in the areas of local function approximations and use of intermediate variable and response quantities. It also appears that some new methodologies are emerging which could greatly benefit from the introduction of new computer architecture. Author

N91-22114# Aeronautical Research Labs., Melbourne (Australia).
FATIGUE TESTING OF THE MK3 MOD0 2000 lb BAIL LUGS: TEST REPORT Aircraft Systems Project Document
J. L. Jaeger Aug. 1990 20 p
(AD-A230858; ARL/SYS-PD-003; DODA-AR-006-071) Copyright Avail: NTIS HC/MF A03 CSCL 13/5

This report details the procedure and results obtained for fatigue tests conducted on 2000 lb bail lugs in accordance with MIL-HDBK-5E. The bail lugs were mounted into the testing rig and subjected to selected levels of cyclic loading until failure occured. For each of the two selected stress ratios of R = 0.1 and 0.6, four to six lugs were tested in order to establish the general shape of the S/N curves. Once the general fatigue curves were established, replicate tests were conducted at a minimum of three evenly spaced maximum load levels, in order to statistically define the fatigue curves. The number of lugs tested at each load level depended on the variability of the results. The output from the calibrated load cell placed in series with the bail lug was monitored visually on an oscilloscope to ensure correct loading of the lugs. A frequency counter was used to count the number of cycles that the lugs were subjected to. Each test item was subjected to a visual examination at the end of the test to note the failure mode. The test details and results are presented. K.S.

N91-22115# Naval Air Development Center, Warminster, PA. Dept. of Air Vehicle and Crew Systems Technology.
SOIL-RESISTANT TREATMENT FOR AIRCRAFT TACTICAL PAINT SCHEMES Final Report, Sep. 1988 - May 1990
Kenneth G. Clark and David L. Gauntt 23 May 1990 36 p
(AD-A231424; NADC-90052-60) Avail: NTIS HC/MF A03 CSCL 11/3

Low gloss tactical paints continue to pose a significant problem for fleet activities. Restrictions on pH(7.0 to 10.0), phosphate content (not allowed) and solvent content (less than 32 percent) have limited the effectiveness of exterior cleaning compounds. This project was initiated to investigate soil-resistant treatments that would either prevent the retention of difficult soils or render the paint system more cleanable. GRA

N91-22116*# Cincinnati Univ., OH. Structural Dynamics Research Lab.
ANALYSIS OF STRUCTURAL RESPONSE DATA USING DISCRETE MODAL FILTERS M.S. Thesis
Lawrence C. Freudinger (National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.) May 1991 78 p
(Grant NAG1-942; NASA Order A-78043-C)
(NASA-CR-179448; H-1693; NAS 1.26:179448) Avail: NTIS HC/MF A05 CSCL 01C

The application of reciprocal modal vectors to the analysis of structural response data is described. Reciprocal modal vectors are constructed using an existing experimental modal model and an existing frequency response matrix of a structure, and can be assembled into a matrix that effectively transforms the data from the physical space to a modal space within a particular frequency

range. In other words, the weighting matrix necessary for modal vector orthogonality (typically the mass matrix) is contained within the reciprocal model matrix. The underlying goal of this work is mostly directed toward observing the modal state responses in the presence of unknown, possibly closed loop forcing functions, thus having an impact on both operating data analysis techniques and independent modal space control techniques. This study investigates the behavior of reciprocol modal vectors as modal filters with respect to certain calculation parameters and their performance with perturbed system frequency response data.
Author

N91-22117*# Sparta, Inc., Laguna Hills, CA.
AUTOMATED FLIGHT TEST MANAGEMENT SYSTEM
M. D. Hewett, D. M. Tartt, and A. Agarwal (Integrated Systems, Inc., Santa Clara, CA.) May 1991 40 p
(Contract NAS2-12670)
(NASA-CR-186011; H-1699; NAS 1.26:186011) Avail: NTIS HC/MF A03 CSCL 01C

The Phase 1 development of an automated flight test management system (ATMS) as a component of a rapid prototyping flight research facility for artificial intelligence (AI) based flight concepts is discussed. The ATMS provides a flight engineer with a set of tools that assist in flight test planning, monitoring, and simulation. The system is also capable of controlling an aircraft during flight test by performing closed loop guidance functions, range management, and maneuver-quality monitoring. The ATMS is being used as a prototypical system to develop a flight research facility for AI based flight systems concepts at NASA Ames Dryden.
Author

N91-22118# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Theoretical Aerodynamics Dept.
AN ITERATIVE PROCEDURE FOR THE DESIGN OF PRESSURE-SPECIFIED 3-DIMENSIONAL CONFIGURATIONS AT SUBSONIC AND SUPERSONIC SPEEDS BY MEANS OF A HIGHER-ORDER PANEL METHOD
L. Fornasier 11 Sep. 1989 13 p Presented at 64th Fluid Dynamics Panel Specialists' Meeting on Computational Methods for Aerodynamic Design (Inverse) and Optimization, Loen, Norway, 22-23 May 1989
(Contract BMVg-T/RF41/E0010/E14)
(MBB-FE122/S/PUB/375; ETN-91-99190) Copyright Avail: NTIS HC/MF A03

An advanced panel method employing singularity distributions of high order and based on mixed Dirichlet and Neumann type boundary conditions was recently developed for the potential flow analysis of arbitrary airplane configurations at subsonic and supersonic speeds. Some work is in progress to provide this method with a design option capable of relofting the surface of a given configuration from prescribed pressure distributions. The mathematical background of the herein used inverse algorithm is presented and some examples of application are discussed.
ESA

N91-22119# Bristol Univ. (England). Dept. of Aerospace Engineering.
THE PRELIMINARY AERODYNAMIC DESIGN OF LIGHT AIRCRAFT B.S. Thesis
P. J. Griffiths and M. A. Standeven Jun. 1990 111 p
(BU-504; ETN-91-99197) Avail: NTIS HC/MF A06

The development of a computer program to aid the preliminary design of light aeroplanes is described. It is written in Borland TURBO PASCAL for use on an IBM PC or compatible computer; thus, providing the light aircraft designer with an inexpensive desktop design tool. The highly structured nature of TURBO PASCAL is exploited to match the overall aircraft design philosophy, as well as providing a modular framework suitable for future expansion. At the end of the study, the program is capable of calculating both the untrimmed and trimmed cruise performance characteristics, simply from the basic aeroplane geometry. The predictions are presented in either tabular or graphical form. However, there do exist reliability problems within the calculation of the trimmed drag coefficients, which could not be solved within the time scale available. This project produced a sound basis for the development of a comprehensive system capable of reducing the time and cost of a preliminary light aircraft design study.
ESA

N91-22120# Bristol Univ. (England). Dept. of Aerospace Engineering.
A QUANTITATIVE INVESTIGATION INTO THE AERODYNAMIC COUPLING EFFECTS IN A COAXIAL CONTRA-ROTATING ROTOR SYSTEM B.S. Thesis
A. Segal and M. Tomblin Jun. 1990 73 p
(BU-517; ETN-91-99210) Avail: NTIS HC/MF A04

The total lift, lift difference and power supplied for a coaxial contrarotating rotor were measured at various speeds separations and incidences. This included differential pitch on upper and lower rotors. Performance comparisons were made at 800 rpm, between 0.4 and 0.12 m separation and with 1 to 9 degs of positive pitch. Lift and lift per kilowatt (a measure of efficiency) were used as a means of comparison between different configurations. The lower rotor was found to perform very poorly in the wake of the upper rotor, producing only between 14 and 28 pct. of the total lift. The optimum overall efficiency was found when the lower rotor produced minimum lift and the separation was about 10 pct. of the rotor's diameter.
ESA

N91-22121*# Hampton Univ., VA. Dept. of Engineering.
EVALUATION OF ON-BOARD HYDROGEN STORAGE METHODS F OR HIGH-SPEED AIRCRAFT Status Report
Ates Akyurtlu and Jale F. Akyurtlu 31 Jan. 1991 95 p
(Grant NAG1-767)
(NASA-CR-187755; NAS 1.26:187755) Avail: NTIS HC/MF A05 CSCL 01C

Hydrogen is the fuel of choice for hypersonic vehicles. Its main disadvantage is its low liquid and solid density. This increases the vehicle volume and hence the drag losses during atmospheric flight. In addition, the dry mass of the vehicle is larger due to larger vehicle structure and fuel tankage. Therefore it is very desirable to find a fuel system with smaller fuel storage requirements without deteriorating the vehicle performance substantially. To evaluate various candidate fuel systems, they were first screened thermodynamically with respect to their energy content and cooling capacities. To evaluate the vehicle performance with different fuel systems, a simple computer model is developed to compute the vehicle parameters such as the vehicle volume, dry mass, effective specific impulse, and payload capacity. The results indicate that if the payload capacity (or the gross lift-off mass) is the most important criterion, only slush hydrogen and liquid hydrogen - liquid methane gel shows better performance than the liquid hydrogen vehicle. If all the advantages of a smaller vehicle are considered and a more accurate mass analysis can be performed, other systems using endothermic fuels such as cyclohexane, and some boranes may prove to be worthy of further consideration.
Author

N91-22318*# Lockheed Aeronautical Systems Co., Burbank, CA.
FLEXIBLE BODY DYNAMIC STABILITY FOR HIGH PERFORMANCE AIRCRAFT
E. A. Goforth, H. M. Youssef, C. V. Apelian, and S. C. Schroeder *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 145-155 (For primary document see N91-22307 14-18)
Avail: NTIS HC/MF A20 CSCL 01C

N91-22333*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AEROELASTIC MODELING OF THE ACTIVE FLEXIBLE WING WIND-TUNNEL MODEL
Walter A. Silva (Lockheed Engineering and Sciences Co., Hampton, VA.), Jennifer Heeg, and Robert M. Bennett *In its* Fourth NASA Workshop on Computational Control of Flexible Aerospace

Systems, Part 2 Mar. 1991 p 497-53 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 01C

06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography.*

No abstracts in this category.

07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxilliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

N91-22122 Cranfield Inst. of Tech., Bedford (England).
EXPERIMENTAL STUDY OF RADIATION FROM COATED TURBINE BLADES Ph.D. Thesis
Arkan Khilkhal Husai Al-taie 1990 301 p
Avail: Univ. Microfilms Order No. BRDX90876

The specific power of modern gas turbines is much influenced by the gas temperature at turbine inlet. Ceramic coatings operate as thermal barriers and can allow gas temperature to be increased by 50 to 220 K. There is little experience in measuring surface temperatures of blades coated with ceramic coatings. There is evidence that the radiation signal picked up by the pyrometer will not only depend on the surface temperature but also on a number of optical properties of the coating. Among these are the emissivity of the coating and whether the coating is translucent. Parameters affecting this are coating material, coating surface finish, coating thickness, and whether or not a bond coat is used. These variables are explored in a rig that simulates the conditions within a turbine stage of a gas turbine engine. Six thermal barrier coating systems were tested, including four stabilized zirconia systems and two alumina based systems. Analysis shows that the measured blade surface temperature was within 10 K of that calculated. The use of 0.3 mm of C-YPSZ on air cooled turbine blades caused 250 K surface temperature increase and 270 K metal temperature decrease for turbine entry temperature of 1673 K. Dissert. Abstr.

N91-22123 Durham Univ. (England).
VALIDATION OF VISCOUS, THREE-DIMENSIONAL FLOW CALCULATIONS IN AN AXIAL TURBINE CASCADE Ph.D. Thesis
James Gilbert Edwin Cleak 1989 356 p
Avail: Univ. Microfilms Order No. BRD90825

A detailed investigation is presented of the capability of a modern three-dimensional Navier-Stokes solver to predict the secondary flows and losses in a linear cascade of high turning turbine rotor blades. Three codes were initially tested, to permit selection of the best of the available numerical solvers for this case. This program was then tested in more detail. Results showed that although very accurate prediction of the effects of inviscid fluid mechanics is now possible, the Reynolds stress modelling can have profound effects upon the quality of the solutions obtained. Solutions using two different calculation meshes, have shown that the results are not significantly grid dependent.
Dissert. Abstr.

N91-22124# Naval Postgraduate School, Monterey, CA.
AN EXPERIMENTAL INVESTIGATION INTO NO(x) CONTROL OF A GAS TURBINE COMBUSTOR AND AUGMENTOR TUBE INCORPORATING A CATALYTIC REDUCTION SYSTEM M.S. Thesis
Christopher K. Behrens Mar. 1990 88 p
(AD-A231427) Avail: NTIS HC/MF A05 CSCL 24/1

An initial experimental investigation was conducted to examine the feasibility of NO(x) emission control using catalytic reduction techniques in the jet engine test cell environment. A modified T-63 gas turbine combustor and an augmentor tube, 21 feet in length and containing a perlite catalyst, were used as a gas generator and catalytic reduction system. Four data runs were made. Three runs were completed without the catalyst installed. Temperature and velocity profile measurements were obtained in order to calculate augmentation ratios for different engine fuel to air ratios. NO(x), CO, and unburned hydrocarbon concentrations in the exhaust were measured to provide a baseline for further tests. A fourth data run was made with the perlite catalyst installed in the augmentor tube. A 64 percent NO(x) reduction was observed, however, the large pressure drop across the catalytic bed deemed the current configuration impractical. Recommendations for alternative configurations are presented. The results of the investigation have proven that further study is warranted. GRA

N91-22125# Marquardt Corp., Van Nuys, CA.
SKIN FRICTION MEASUREMENT TECHNIQUES FOR SCRAMJET APPLICATIONS. PHASE 1: PRELIMINARY DESIGN Final Report, Sep. 1989 - Feb. 1990
R. C. Steele Aug. 1990 60 p
(Contract F33615-87-C-2755)
(AD-A231899; MR-S-1800-Phase-1; WRDC-TR-90-2062-Phase-1)
Avail: NTIS HC/MF A04 CSCL 20/4

The objective of this program was to carry out a preliminary design of a gauge to measure skin friction of a scramjet combustor. Preliminary designs of two skin friction measurement approaches have been completed. The work was accomplished by the Marquardt Company and a subcontracted group from Virginia Polytechnic Institute (VPI). With the recent interest in hypersonic flight the challenge to obtain accurate skin friction measurements has became necessary. For example, at a flight condition of Mach 8 at 100,000 feet altitude the estimated skin friction drag of a scramjet engine is approximately 36 percent of the net thrust. The environment within a scramjet combustor is extremely hostile of any physical object, thus increasing the difficulty of successful measurement of skin friction. The first approach reported is the Cantilever Beam (Design A) design based on the use of a multi-purpose displacement transducer which has the property of being very sensitive while still being stiff. The second or the Thin Film (Design B) approach is a newly established concept by VPI. The design exploits thin film sputtering technology for the purpose of attaching microstrain gauges. GRA

N91-22126*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
APPLICATION OF MIXING-CONTROLLED COMBUSTION MODELS TO GAS TURBINE COMBUSTORS
Hung Lee Nguyen 1990 13 p Presented at the Joint Symposium on General Aviation Systems, Ocean City, NJ, 11-12 Apr. 1990; sponsored by AIAA and FAA Original contains color illustrations
(NASA-TM-103236; E-5649; NAS 1.15:103236) Avail: NTIS HC/MF A03; 5 functional color pages CSCL 21E

Gas emissions were studied from a staged Rich Burn/Quick-Quench Mix/Lean Burn combustor were studied under test conditions encountered in High Speed Research engines. The combustor was modeled at conditions corresponding to different engine power settings, and the effect of primary dilution airflow split on emissions, flow field, flame size and shape, and combustion intensity, as well as mixing, was investigated. A mathematical model was developed from a two-equation model of turbulence, a quasi-global kinetics mechanism for the oxidation of propane, and the Zeldovich mechanism for nitric oxide formation. A mixing-controlled combustion model was used to account for

turbulent mixing effects on the chemical reaction rate. This model assumes that the chemical reaction rate is much faster than the turbulent mixing rate. Author

08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

For related information see also *05 Aircraft Design, Testing and Performance.*

N91-22127*# Washington Univ., Seattle. Dept. of Aeronautics and Astronautics.
ROBUST INTEGRATED AUTOPILOT/AUTOTHROTTLE DESIGN USING CONSTRAINED PARAMETER OPTIMIZATION Final Report, 16 Sep. 1988 - 16 Sep. 1990
Uy-Loi Ly, Christopher Voth, and Swamy Sanjay 1990 203 p (Grant NAG1-193)
(NASA-CR-188011; NAS 1.26:188011) Avail: NTIS HC/MF A10 CSCL 01C

A multivariable control design method based on constrained parameter optimization was applied to the design of a multiloop aircraft flight control system. Specifically, the design method is applied to the following: (1) direct synthesis of a multivariable 'inner-loop' feedback control system based on total energy control principles; (2) synthesis of speed/altitude-hold designs as 'outer-loop' feedback/feedforward control systems around the above inner loop; and (3) direct synthesis of a combined 'inner-loop' and 'outer-loop' multivariable control system. The design procedure offers a direct and structured approach for the determination of a set of controller gains that meet design specifications in closed-loop stability, command tracking performance, disturbance rejection, and limits on control activities. The presented approach may be applied to a broader class of multiloop flight control systems. Direct tradeoffs between many real design goals are rendered systematic by this method following careful problem formulation of the design objectives and constraints. Performance characteristics of the optimization design were improved over the current autopilot design on the B737-100 Transport Research Vehicle (TSRV) at the landing approach and cruise flight conditions; particularly in the areas of closed-loop damping, command responses, and control activity in the presence of turbulence. Author

N91-22128 Rutgers - The State Univ., New Brunswick, NJ.
RELIABILITY ISSUES IN STRUCTURAL CONTROL: COMPONENT PLACEMENT AND SENSOR FAILURE DETECTION Ph.D. Thesis
Kangyoun Choe 1990 145 p
Avail: Univ. Microfilms Order No. DA9100882

Reliability problems associated with the control of flexible structures are considered. The equations of motion associated with reliability problems encountered in the dynamics and control of flexible structures are formulated. The optimal placement of sensors and actuators is analyzed, and a procedure is proposed for sensor failure detection. In the sensor placement problem optimization procedures are used to determine the most desirable locations of the operational sensors. The number and location of backup sensors are also considered. The objective functions are based on minimizing the errors in the extraction of modal coordinates. The modal coordinates are extracted using modal filters from the sensors' measurements. For the implementation of modal filters, new types of interpolation functions, spline functions, are introduced. It is shown that model filtering using spline functions is generally more desirable than using finite-element type or Rayleigh-Ritz type interpolation functions because of stability, robustness, and convergence considerations. Actuator placement for structural control is considered next. Optimization studies are conducted where a variety of objective functions are formulated. The implementation of the control using piecewise continuous actuators is considered. A new sensor failure detection procedure is developed, where modal observers are used to estimate the modal coordinates. These modal estimates are synthesized to generate estimates of the sensor measurements, and these estimates are compared with the actual measurements for the detection of faulty sensors. The observers are designed for each mode independently of the other modes; thus, the failure detection procedure can be easily implemented to the high-order systems. The effects of failure of one sensor on the propagation of the estimation error are formulated. This procedure can be used to detect multiple sensor failures. Dissert. Abstr.

N91-22129 State Univ. of New York, Buffalo.
TRANSIENT DESCRIPTORS AS PERFORMANCE CRITERIA IN THE DYNAMICS AND CONTROL OF VIBRATING SYSTEMS Ph.D. Thesis
Alpha D. S. Ross 1990 189 p
Avail: Univ. Microfilms Order No. DA9033733

Transient descriptors are developed as performance criteria for analyzing the dynamics of and assisting in designing the control scheme for vibrating systems. First, the concepts of transient descriptors are extended to asymmetric multiple degree of freedom (MDOF) systems. Next, these concepts are applied to the 'actuator sensor strut' placement problem. Three common transient descriptors are addressed. First, a vector form of the transient response amplitude bound (TRAB) transient descriptor is developed. The TRAB has two parts: an initial value and a rate of decay. Second, a vector form of the transient response amplitude maximum (TRAM) transient descriptor is developed. The TRAM provides more precise information about the magnitude of the transient response amplitude than the initial value of the TRAB. An algorithm for computing the TRAM using the TRAB is outlined. Third, the settling time transient descriptor is defined with respect to the total energy of an asymmetric MDOF system. To compute the total system energy requires converting the asymmetric MDOF model to an equivalent symmetric form. Usage of the three transient descriptors in the 'actuator sensor strut' placement problem is illustrated. Dissert. Abstr.

N91-22130# Harris Corp., Melbourne, FL. Government Aerospace Systems Div.
ACTIVE NONLINEAR FEEDBACK CONTROL FOR AEROSPACE SYSTEMS: PROCESSOR Annual Report, 1 Dec. 1989 - 1 Dec. 1990
David C. Hyland and Dennis S. Bernstein Dec. 1990 168 p (Contract F49620-89-C-0029)
(AD-A231929; AFOSR-91-0042TR) Avail: NTIS HC/MF A08 CSCL 22/1

Although the theory of linear control systems is highly mature, nonlinear control-system design techniques remain relatively undeveloped. In real-world applications such as vibrations suppression in flexible structures and large angle rigid-body spacecraft maneuvers, nonlinear plants generally require nonlinear controllers, while linear plants often benefit from the implementation of nonlinear controllers in the presence of structured plant uncertainty, actuator constraints, and nonquadratic performance criteria. Progress in several areas relating to the role of nonlinearities in feedback control is discussed. These area include Lyapunov function theory, chaotic controllers, statistical energy analysis, phase robustness, and optimal nonlinear control theory. GRA

N91-22131*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
RESEARCH FLIGHT-CONTROL SYSTEM DEVELOPMENT FOR THE F-18 HIGH ALPHA RESEARCH VEHICLE
Joseph W. Pahle, Bruce Powers, Victoria Regenie, Vince Chacon, Steve Degroote, and Steven Murnyak (McDonnell Aircraft Co., Saint Louis, MO.) Apr. 1991 25 p Presented at the High-Angle-of-Attack Technology Conference, Hampton, VA, 30 Oct. - 1 Nov. 1990
(NASA-TM-104232; H-1715; NAS 1.15:104232) Avail: NTIS HC/MF A03 CSCL 01C

The F-18 high alpha research vehicle was recently modified by adding a thrust vectoring control system. A key element in the

modification was the development of a research flight control system integrated with the basic F-18 flight control system. Discussed here are design requirements, system development, and research utility of the resulting configuration as an embedded system for flight research in the high angle of attack regime. Particular emphasis is given to control system modifications and control law features required for high angle of attack flight. Simulation results are used to illustrate some of the thrust vectoring control system capabilities and predicted maneuvering improvements. Author

N91-22132# Bristol Univ. (England). Dept. of Aerospace Engineering.
SIGNAL BLENDING IN CONTROL SYSTEMS STRUCTURAL INTERACTIONS B.S. Thesis
R. M. Hart and J. C. Rutler Jun. 1990 63 p
(BU-505; ETN-91-99198) Avail: NTIS HC/MF A04

Flexible modes of vibration must be removed from the feedback control system of an aircraft. A computer model of a rig, which was being used to model an aircraft fuselage as a simple beam, was created in order to calculate the gains required to remove these modes of vibration using signal blending, instead of notch filters with their associated problems. This was achieved successfully, and the effects of variations of stiffness and damping, that occur when an aircraft is in flight, on signal blending were investigated using the computer model. ESA

N91-22133# Bristol Univ. (England). Dept. of Aerospace Engineering.
FLUTTER SUPPRESSION OF AN AIRCRAFT WING USING A CONTROL SURFACE B.S. Thesis
N. P. Jackson and D. J. Tostevin Jun. 1990 128 p
(BU-506; ETN-91-99199) Avail: NTIS HC/MF A07

A set of techniques was devised to design a control system to suppress the onset of hard and soft flutter to a higher speed. The study was a purely theoretical analysis carried out an two wing models: a tip missile configuration which exhibited hard flutter, and an engine pylon configuation which exhibited soft flutter. The method of flutter control used frequency response data fits around unity radius encirclements of the 1 point on Nyquist plots. These methods were revised and made much more efficient and easy to use giving better results than achieved before. The engine pylon (soft flutter) model was suppressed to 1.37 Vf using the onboard pair of tranducers as defined by BAe (British Aerospace), and the tip missile (hard flutter) model was suprressed to 1.73 Vf using all four BAe transducers as defined by BAe. These control laws gave stability between the original flutter speeds and those as above so gain scheduling against velocity was not required. Using an optical transducer positioning method, the soft flutter model was suppressed further, to 1.46 Vf but the outboard transducers were found to be in the optimal position for the hard flutter model. ESA

N91-22134# Bristol Univ. (England). Dept. of Aerospace Engineering.
ASSESSMENT OF HIGH PRESSURE AND VARIABLE PRESSURE ACTUATION SYSTEMS BY MATHEMATICAL MODELLING B.S. Thesis
D. J. Williams and M. P. Williams Jun. 1990 93 p
(BU-521; ETN-91-99214) Avail: NTIS HC/MF A05

An initial assessment was made of two future concepts for combat aircraft hydraulic actuation systems; a high pressure/reduced piston area system, and a variable pressure system. It is known that the frequency response and impedence of the conventional actuation system operating at high pressure are unsatisfactory. Various feedbacks were investigated with a view to improving these characteristics. It was shown in principle that velocity feedback could restore the actuator characteristics, and this was confirmed by runs of a mathematical model of the system with the various lags eliminated. However, with the lags included, the benefits were lost, because the inertia mode was driven to instability. The variable pressure system was modeled using an orifice to represent the actuator flow demand on the system. An accumulator and recuperator were required to maintain a sufficiently high pressure over a variety of flow demands. The output pressure of the pump was determined from feedback of the orifice displacement. The response of the system to a few inputs was demonstrated and it seems likely that a variable pressure system is feasible in the future. ESA

N91-22135*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
LIFE EXTENDING CONTROL: A CONCEPT PAPER
Carl F. Lorenzo and Walter C. Merrill 1991 17 p Presented at the American Control Conference, Boston, MA, 26-28 Jun. 1991; sponsored by the American Automatic Control Council
(NASA-TM-104391; E-6206; NAS 1.15:104391) Avail: NTIS HC/MF A03 CSCL 01C

The concept of Life Extending Control is defined. Life is defined in terms of mechanical fatigue life. A brief description is given of the current approach to life prediction using a local, cyclic, stress-strain approach for a critical system component. An alternative approach to life prediction based on a continuous functional relationship to component performance is proposed.Base on cyclic life prediction an approach to Life Extending Control, called the Life Management Approach is proposed. A second approach, also based on cyclic life prediction, called the Implicit Approach, is presented. Assuming the existence of the alternative functional life prediction approach, two additional concepts for Life Extending Control are presented. Author

N91-22107# National Research Council of Canada, Ottawa (Ontario).
OSCILLATORY TEST TECHNIQUES
E. S. Hanff and C. O. OLeary (Royal Aircraft Establishment, Bedford, England) *In* AGARD, Special Course on Aircraft Dynamics at High Angles of Attack: Experiments and Modelling Mar. 1991 12 p (For primary document see N91-22104 14-05)
Copyright Avail: NTIS HC/MF A07; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

N91-22332*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN OVERVIEW OF THE ACTIVE FLEXIBLE WING PROGRAM
Stanley R. Cole, Boyd Perry, III, and Gerald D. Miller (Rockwell International Corp., Los Angeles, CA.) *In its* Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 459-49 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 01C

N91-22334*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DESIGN AND TEST OF THREE ACTIVE FLUTTER SUPPRESSION CONTROLLERS
David M. Christhilf, Martin R. Waszak, William M. Adams, S. Srinathkumar (Naticnal Aeronautical Lab., Bangalore, India), and Vivek Mukhopadhyay *In its* Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 535-56 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 01C

N91-22335*# Rockwell International Corp., Los Angeles, CA.
ROLL PLUS MANEUVER LOAD ALLEVIATION CONTROL SYSTEM DESIGNS FOR THE ACTIVE FLEXIBLE WING WIND-TUNNEL MODEL
Douglas B. Moore, Gerald D. Miller, and Martin J. Klepl *In* NASA, Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 561-582 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 01C

N91-22336*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DEVELOPMENT, SIMULATION VALIDATION, AND WIND TUNNEL TESTING OF A DIGITAL CONTROLLER SYSTEM FOR FLUTTER SUPPRESSION
Sherwood Tiffany Hoadley, Carey S. Buttrill, Sandra M. McGraw (Lockheed Engineering and Sciences Co., Hampton, VA.), and Jacob A. Houck *In its* Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 583-61 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 01C

N91-22337*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DEVELOPMENT AND TESTING OF CONTROLLER PERFORMANCE EVALUATION METHODOLOGY FOR MULTI-INPUT/MULTI-OUTPUT DIGITAL CONTROL SYSTEMS
Anthony Pototzky (Lockheed Engineering and Sciences Co., Hampton, VA.), Carol Wieseman, Sherwood Tiffany Hoadley, and Vivek Mukhopadhyay *In its* Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 615-65 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 01C

N91-23053*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CIVIL AIR TRANSPORT: A FRESH LOOK AT POWER-BY-WIRE AND FLY-BY-LIGHT
Gale R. Sundberg *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 263-267 Previously announced as N90-21283 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 01C

09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

For related information see also *14 Ground Support Systems and Facilities (Space).*

N91-22136# Aeronautical Research Labs., Melbourne (Australia).
AEROTHERMODYNAMIC DESIGN APPRAISAL OF NOISE SUPPRESSORS FOR F/A-18 ENGINE RUN-UP FACILITIES AT RAAF WILLIAMTOWN
S. A. Fisher and A. M. Abdel-Fattah Oct. 1990 66 p
(ARL-PROP-R-177; AR-006-126) Copyright Avail: NTIS HC/MF A04

Upgraded facilities for ground running of F404 engines in F/A-18 aircraft at RAAF Williamtown will feature air-cooled exhaust augmentors for noise suppression. Aerothermodynamical aspects of the augmentor designs were appraised in some detail, making use of isothermal scale model tests, ejector theory, and available empirical data. In initial design development, quantitative assessments were made of cooling flow pumping performance. Changes were recommended to improve the aerodynamic characteristics of the exhaust augmentors and eliminate high risk features, and the sizes of the augmentor ducts were significantly reduced. The model tests identified certain geometric features which were important for symmetry of the flow in the augmentor ducts and to pumping performance. Once modified accordingly, the designs displayed satisfactory aerodynamic behavior, which was tolerant to both inlet asymmetries and reasonable levels of engine jet misalignment. The pumping performance was shown to exceed the design requirements. Author

N91-22137# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
STATUS OF PAVER IMPLEMENTATION WITHIN THE US AIR FORCE M.S. Thesis
C. L. Eaddy Dec. 1990 164 p
(AD-A231158; AFIT/CI/CIA-90-126) Avail: NTIS HC/MF A08 CSCL 13/2

Regardless of how well conceived a pavement management system (PMS) is, unless well implemented and accepted by the end user its benefits cannot be realized. This paper seeks to estimate the present status of implementation within the U.S. Air Force of the pavement management system, PAVER. This work is based in part on an initial effort by Captain Timothy R. McLean who in 1984 wrote his graduate thesis on improving PAVER implementation. In his research he sought to determine the problems encountered in the field during the implementation of PAVER as well as recommendations from the field for improving or refining PAVER. He identified training, manpower, equipment, and top management support as key areas requiring attention to improve PAVER implementation. This work seeks to estimate and validate not only the present extent of these pre-identified problem areas, but also the current extent of PAVER's use and application. Example areas which the questionnaire addresses include an estimation of the following: the number of air bases which have partially or fully implemented PAVER; the accuracy of pavement distress and inventory data being used; the application of PAVER to project programming; the ranking of benefits from using PAVER; and preceptions of PAVER as an innovation which have been identified in various literature as factors influencing the diffusion of innovation. GRA

N91-22138# Army Cold Regions Research and Engineering Lab., Hanover, NH.
SNOW ROADS AND RUNWAYS
Gunars Abele Nov. 1990 109 p
(AD-A231490; CRREL-90-3) Avail: NTIS HC/MF A06 CSCL 08/12

This monograph presents a complete review of all successful techniques that have been used to construct and maintain snow roads, trails, and aircraft landing fields. The snow properties that must be considered prior to the construction process are identified, and the kinds of apparatus available for the measure of the properties are reviewed and assessed. A discussion of construction techniques is presented and includes the following: (1) types of snow pavements; (2) classification of roads by use; (3) classification of surface and subsurface strength; (4) considerations impacting on site selection; (5) various kinds of equipment that have been developed to construct and maintain the roads; and (6) additives that have been used to construct roads with sufficient bearing strength. The design criteria that have been established are cited. GRA

12 ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see *91 Lunar and Planetary Exploration.*

N91-22139*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
VISION-21: SPACE TRAVEL FOR THE NEXT MILLENNIUM
Geoffrey A. Landis, ed. (Sverdrup Technology, Inc., Brook Park, OH.) Apr. 1990 600 p Symposium held in Cleveland, OH, 3-4 Apr. 1990
(NASA-CP-10059; E-5838; NAS 1.55:10059) Avail: NTIS HC/MF A25 CSCL 22A

The papers from this symposium, that was held at the NASA Lewis Research Center on April 3-4, 1990, are presented. The theme selected for the symposium was space travel for the next millennium. It was hoped that the participants would allow their focus to consider possible advances in technologies for space travel not just for currently envisioned projects, but for possibilities beyond the next generation and the next thousand years. About

half of the contributed papers focussed on propulsion and the other half on other issues related to space travel. For individual titles, see N91-22140 through N91-22181.

N91-22140*# Forward Unltd., Malibu, CA.
EXOTIC POWER AND PROPULSION CONCEPTS **c20**
Robert L. Forward *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 11-36 (For primary document see N91-22139 14-12)
(Contract F04611-87-C-0029)
Avail: NTIS HC/MF A25 CSCL 21H

The status of some exotic physical phenomena and unconventional spacecraft concepts that might produce breakthroughs in power and propulsion in the 21st Century are reviewed. The subjects covered include: electric, nuclear fission, nuclear fusion, antimatter, high energy density materials, metallic hydrogen, laser thermal, solar thermal, solar sail, magnetic sail, and tether propulsion. Author

N91-22141*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
INDUSTRIALIZING THE NEAR-EARTH ASTEROIDS: SPECULATIONS ON HUMAN ACTIVITIES IN SPACE IN THE LATTER HALF OF THE 21ST CENTURY **c90**
Joel C. Sercel *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 37-53 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 03B

The use of solar system resources for human industry can be viewed as a natural extension of the continual growth of our species' habitat. Motivations for human activities in space can be discussed in terms of five distinct areas: (1) information processing and collection; (2) materials processing; (3) energy production to meet terrestrial power needs; (4) the use of extraterrestrial materials; and (5) disaster avoidance. When considering 21st-Century activities in space, each of these basic motivations must be treated in light of issues likely to be relevant to the 21st-Century earth. Many of the problems facing 21st-Century earth may stem from the need to maintain the world population of 8 to 10 billion people as is projected from expected growth rates. These problems are likely to include managing the impact of industrial processes on the terrestrial biosphere while providing adequate energy production and material goods for the growing population. The most important human activities in space in the latter half of the 21st Century may be associated with harnessing the resources of the near-earth asteroids for industrial processes. These above topics are discussed with an emphasis on space industrialization. Author

N91-22142*# Massachusetts Inst. of Tech., Cambridge.
PROPOSAL FOR A REMOTELY MANNED SPACE STATION **c18**
Marvin Minsky *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 58-67 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22B

The United States is in trouble in space. The costs of the proposed Space Station Freedom have grown beyond reach, and the present design is obsolete. The trouble has come from imagining that there are only two alternatives: manned vs. unmanned. Both choices have led us into designs that do not appear to be practical. On one side, the United States simply does not possess the robotic technology needed to operate or assemble a sophisticated unmanned space station. On the other side, the manned designs that are now under way seem far too costly and dangerous, with all of its thousands of extravehicular activity (EVA) hours. More would be accomplished at far less cost by proceeding in a different way. The design of a space station made of modular, Erector Set-like parts is proposed which is to be assembled using earth-based remotely-controlled binary-tree telerobots. Earth-based workers could be trained to build the station in space using simulators. A small preassembled spacecraft would be launched with a few telerobots, and then, telerobots could be ferried into orbit along with stocks of additional parts. Trained terrestrial workers would remotely assemble a larger station, and materials for additional power and life support systems could be launched. Finally, human scientists and explorers could be sent to the space station. Other aspects of such a space station program are discussed. Author

N91-22143*# National Aeronautics and Space Administration, Washington, DC.
ADVANCED INTERDISCIPLINARY TECHNOLOGIES
John L. Anderson *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 76-92 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22A

The following topics are presented in view graph form: (1) breakthrough trust (space research and technology assessment); (2) bionics (technology derivatives from biological systems); (3) biodynamics (modeling of human biomechanical performance based on anatomical data); and (4) tethered atmospheric research probes. K.S.

N91-22144*# Brookhaven National Lab., Upton, NY.
ULTRA HIGH TEMPERATURE PARTICLE BED REACTOR DESIGN **c73**
Otto Lazareth, Hans Ludewig, K. Perkins, and J. Powell *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 107-113 (For primary document see N91-22139 14-12)
(Contract DE-AC02-76CH-00016)
Avail: NTIS HC/MF A25 CSCL 18I

A direct nuclear propulsion engine which could be used for a mission to Mars is designed. The main features of this reactor design are high values for I(sub sp) and very efficient cooling. This particle bed reactor consists of 37 cylindrical fuel elements embedded in a cylinder of beryllium which acts as a moderator and reflector. The fuel consists of a packed bed of spherical fissionable fuel particles. Gaseous H2 passes over the fuel bed, removes the heat, and is exhausted out of the rocket. The design was found to be neutronically critical and to have tolerable heating rates. Therefore, this particle bed reactor design is suitable as a propulsion unit for this mission. Author

N91-22145*# Brookhaven National Lab., Upton, NY.
THE LIQUID ANNULAR REACTOR SYSTEM (LARS) PROPULSION **c20**
James Powell, Hans Ludewig, Frederick Horn, and Roger Lenard (Strategic Defense Initiative Organization, Washington, DC.) *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 114-123 (For primary document see N91-22139 14-12)
(Contract DE-AC02-76CH-00016)
Avail: NTIS HC/MF A25 CSCL 21H

A concept for very high specific impulse (greater than 2000 seconds) direct nuclear propulsion is described. The concept, termed the liquid annular reactor system (LARS), uses liquid nuclear fuel elements to heat hydrogen propellant to very high temperatures (approximately 6000 K). Operating pressure is moderate (approximately 10 atm), with the result that the outlet hydrogen is virtually 100 percent dissociated to monatomic H. The molten fuel is contained in a solid container of its own material, which is rotated to stabilize the liquid layer by centripetal force. LARS reactor designs are described, together with neutronic and thermal-hydraulic analyses. Power levels are on the order of 200 megawatts. Typically, LARS designs use seven rotating fuel elements, are beryllium moderated, and have critical radii of approximately 100 cm (core L/D approximately equal to 1.5). Author

N91-22146*# Martin Marietta Aerospace, Denver, CO.
NUCLEAR THERMAL ROCKETS USING INDIGENOUS EXTRATERRESTRIAL PROPELLANTS **c20**
Robert M. Zubrin *In* NASA. Lewis Research Center, Vision-21:

Space Travel for the Next Millennium Apr. 1990 p 124-140 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

A preliminary examination of a concept for a Mars and outer solar system exploratory vehicle is presented. Propulsion is provided by utilizing a nuclear thermal reactor to heat a propellant volatile indigenous to the destination world to form a high thrust rocket exhaust. Candidate propellants, whose performance, materials compatibility, and ease of acquisition are examined and include carbon dioxide, water, methane, nitrogen, carbon monoxide, and argon. Ballistics and winged supersonic configurations are discussed. It is shown that the use of this method of propulsion potentially offers high payoff to a manned Mars mission. This is accomplished by sharply reducing the initial mission mass required in low earth orbit, and by providing Mars explorers with greatly enhanced mobility in traveling about the planet through the use of a vehicle that can refuel itself each time it lands. Thus, the nuclear landing craft is utilized in combination with a hydrogen-fueled nuclear-thermal interplanetary launch. By utilizing such a system in the outer solar system, a low level aerial reconnaissance of Titan combined with a multiple sample return from nearly every satellite of Saturn can be accomplished in a single launch of a Titan 4 or the Space Transportation System (STS). Similarly a multiple sample return from Callisto, Ganymede, and Europa can also be accomplished in one launch of a Titan 4 or the STS. Author

N91-22147*# Illinois Univ., Urbana. Dept. of Nuclear Engineering.
AN APPROACH TO SPACE POWER c20
G. H. Miley, J. H. Nadler, T. Hochberg, O. Barnouin, and Y. B. Gu *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 141-149 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

Fusion offers the potential for a very high specific power, providing a large specific impulse that can be traded-off with thrust for mission optimization. Thus fusion is a leading candidate for missions beyond the moon. A new approach is discussed for space fusion power, namely Inertial Electrostatic Confinement (IEC). This method offers a high power density in a relatively small, simple device. It appears capable of burning aneutronic fuels which are most desirable for space applications and is well suited for direct conversion. An experimental device to test the concept is described. Author

N91-22148*# National Aeronautics and Space Administration, Washington, DC.
THE NASA-LEWIS PROGRAM ON FUSION ENERGY FOR SPACE POWER AND PROPULSION, 1958-1978 c20
Norman R. Schulze and J. Reece Roth (Tennessee Univ., Knoxville.) *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 150-156 Submitted for publication (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

An historical synopsis is provided of the NASA-Lewis research program on fusion energy for space power and propulsion systems. It was initiated to explore the potential applications of fusion energy to space power and propulsion systems. Some fusion related accomplishments and program areas covered include: basic research on the Electric Field Bumpy Torus (EFBT) magnetoelectric fusion containment concept, including identification of its radial transport mechanism and confinement time scaling; operation of the Pilot Rig mirror machine, the first superconducting magnet facility to be used in plasma physics or fusion research; operation of the Superconducting Bumpy Torus magnet facility, first used to generate a toroidal magnetic field; steady state production of neutrons from DD reactions; studies of the direct conversion of plasma enthalpy to thrust by a direct fusion rocket via propellant addition and magnetic nozzles; power and propulsion system studies, including D(3)He power balance, neutron shielding, and refrigeration requirements; and development of large volume, high field superconducting and cryogenic magnet technology. Author

N91-22149*# Tennessee Univ., Knoxville. Dept. of Electrical and Computer Engineering.
SAFETY AND ENVIRONMENTAL CONSTRAINTS ON SPACE APPLICATIONS OF FUSION ENERGY c20
J. Reece Roth *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 157-169 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

Some of the constraints are examined on fusion reactions, plasma confinement systems, and fusion reactors that are intended for such space related missions as manned or unmanned operations in near earth orbit, interplanetary missions, or requirements of the SDI program. Of the many constraints on space power and propulsion systems, those arising from safety and environmental considerations are emphasized since these considerations place severe constraints on some fusion systems and have not been adequately treated in previous studies. Author

N91-22150*# Cincinnati Univ., OH. Dept. of Aerospace Engineering.
ATTITUDE CONTROL REQUIREMENTS FOR VARIOUS SOLAR SAIL MISSIONS
Trevor Williams *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 170-178 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22A

The differences are summarized between the attitude control requirements for various types of proposed solar sail missions (Earth orbiting; heliocentric; asteroid rendezvous). In particular, it is pointed out that the most demanding type of mission is the Earth orbiting one, with the solar orbit case quite benign and asteroid station keeping only slightly more difficult. It is then shown, using numerical results derived for the British Solar Sail Group Earth orbiting design, that the disturbance torques acting on a realistic sail can completely dominate the torques required for nominal maneuvering of an 'ideal' sail. This is obviously an important consideration when sizing control actuators; not so obvious is the fact that it makes the standard rotating vane actuator unsatisfactory in practice. The reason for this is given, and a set of new actuators described which avoids the difficulty. Author

N91-22151*# General Atomic Co., San Diego, CA.
PULSED PLASMOID ELECTRIC PROPULSION c20
Robert F. Bourque, Paul B. Parks, and Teruo Tamano *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 179-192 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

A method of electric propulsion is explored where plasmoids such as spheromaks and field reversed configurations (FRC) are formed and then allowed to expand down a diverging conducting shell. The plasmoids contain a toroidal electric current that provides both heating and a confining magnetic field. They are free to translate because there are no externally supplied magnetic fields that would restrict motion. Image currents in the diverging conducting shell keep the plasmoids from contacting the wall. Because these currents translate relative to the wall, losses due to magnetic flux diffusion into the wall are minimized. During the expansion of the plasma in the diverging cone, both the inductive and thermal plasma energy are converted to directed kinetic energy producing thrust. Specific impulses can be in the 4000 to 20000 sec range with thrusts from 0.1 to 1000 Newtons, depending on available power. Author

N91-22152*# Physical Sciences, Inc., Andover, MA.
LASER DRIVEN LAUNCH VEHICLES FOR CONTINUOUS ACCESS TO SPACE c15
C. J. Rollins, A. Bailey, A. Gelb, M. Gauthier, C. Goldey, E. Lo, D. Resendes, D. Rosen, and G. Weyl *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 193-201 (For primary document see N91-22139

14-12)
Avail: NTIS HC/MF A25 CSCL 22B

The availability of megawatt laser systems in the next century will make laser launch systems from ground to orbit feasible and useful. Systems studies indicate launch capabilities of 1 ton payload per gigawatt laser power. Recent research in ground to orbit laser propulsion has emphasized laser supported detonation wave thrusters driven by repetitively pulsed infrared lasers. In this propulsion concept each laser repetition cycle consists of two pulses. A lower energy first pulse is used to vaporize a small amount of solid propellant and then after a brief expansion period, a second and higher energy laser pulse is used to drive a detonation wave through the expanded vapor. The results are reported of numerical studies comparing the detonation wave properties of various candidate propellants, and the simulation of thruster performance under realistic conditions. Experimental measurements designed to test the theoretical predictions are also presented. Measurements are discussed of radiance and opacity in absorption waves, and mass loss and momentum transfer. These data are interpreted in terms of specific impulse and energy conversion efficiency. Author

N91-22153*# Boeing Aerospace Co., Seattle, WA.
USE OF MAGNETIC SAILS FOR ADVANCED EXPLORATION MISSIONS
Dana G. Andrews and Robert M. Zubrin (Martin Marietta Aerospace, Denver, CO.) *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 202-210 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22A

The magnetic sail, or magsail, is a field effect device which interacts with the ambient solar wind or interstellar medium over a considerable volume of space to generate drag and lift forces. Two theories describing the method of thrust generation are analyzed and data results are presented. The techniques for maintaining superconductor temperatures in interplanetary space are analyzed and low risk options presented. Comparisons are presented showing mission performance differences between currently proposed spacecraft using chemical and electric propulsion systems, and a Magsail propelled spacecraft capable of generating an average thrust of 250 Newtons at a radius of one A.U. The magsail also provides unique capabilities for interstellar missions, in that at relativistic speeds the magnetic field would ionize and deflect the interstellar medium producing a large drag force. This would make it an ideal brake for decelerating a spacecraft from relativistic speeds and then maneuvering within the target star system. Author

N91-22154*# Technische Univ., Berlin (Germany, F.R.). Aerospace Inst.
COMPARISON OF SUPER-HIGH-ENERGY-PROPULSION-SYSTEMS BASED ON METALLIC HYDROGEN PROPELLANT FOR ES TO LEO SPACE TRANSPORTATION **c28**
M. Thierschmann *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 211-227 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21I

The application is studied of metallic H2 as a rocket propellant, which contains a specific energy of about 52 kcal/g in theory yielding a maximum specific impulse of 1700 s. With the convincing advantage of having a density 14 times that of conventional liquid H2/liquid O2 propellants, metallic H2 could satisfy the demands of advanced launch vehicle propulsion for the next millennium. Provided that there is an atomic metallic state of H2, and that this state is metastable at ambient pressure, which still is not proven, the results are given of the study of some important areas, which concern the production of metallic H2, the combustion, chamber cooling, and storage. The results show that the use of metallic H2 as rocket propellant could lead to revolutionary changes in space vehicle philosophy toward small size, small weight, and high performance single stage to orbit systems. The use of high metallic H2 mass fractions results in a dramatic reduction of required propellant volume, while gas temperatures in the combustion chamber exceed 5000 K. Furthermore, it follows, that H2 (liquid or slush) is the most favorable candidate as working fluid. Jet generated noise due to high exhaust velocities could be a problem. Author

N91-22155*# McDonnell-Douglas Space Systems Co., Huntington Beach, CA.
THE 21ST CENTURY PROPULSION **c20**
V. E. Haloulakos and C. Boehmer *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 228-251 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

The prediction of future space travel in the next millennium starts by examining the past and extrapolating into the far future. Goals for the 21st century include expanded space travel and establishment of permanent manned outposts, and representation of Lunar and Mars outposts as the most immediate future in space. Nuclear stage design/program considerations; launch considerations for manned Mars missions; and far future propulsion schemes are outlined. B.G.

N91-22156*# Rensselaer Polytechnic Inst., Troy, NY.
LASER-BOOSTED LIGHTCRAFT TECHNOLOGY DEMONSTRATOR **c15**
J. C. Richard, C. Morales, W. L. Smith, and L. N. Myrabo *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 252-264 Previously announced in IAA as A89-54360 Sponsored in part by Lawrence Livermore National Lab., CA (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22B

The detailed description and performance analysis of a 1.4 meter diameter Lightcraft Technology Demonstator (LTD) is presented. The launch system employs a 100 MW-class ground-based laser to transmit power directly to an advanced combined-cycle engine that propels the 120 kg LTD to orbit - with a mass ratio of two. The single-stage-to-orbit (SSTO) LTD machine then becomes an autonomous sensor satellite that can deliver precise, high quality information typical of today's large orbital platforms. The dominant motivation behind this study is to provide an example of how laser propulsion and its low launch costs can induce a comparable order-of-magnitude reduction in sensor satellite packaging costs. The issue is simply one of production technology for future, survivable SSTO aerospace vehicles that intimately share both laser propulsion engine and satellite functional hardware. Author

N91-22157*# Lawrence Livermore National Lab., CA.
GROUND-TO-ORBIT LASER PROPULSION: ADVANCED APPLICATIONS **c36**
Jordin T. Kare *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 265-275 (For primary document see N91-22139 14-12)
(Contract W-7405-eng-48)
Avail: NTIS HC/MF A25 CSCL 20E

Laser propulsion uses a large fixed laser to supply energy to heat an inert propellant in a rocket thruster. Such a system has two potential advantages: extreme simplicity of the thruster, and potentially high performance, particularly high exhaust velocity. By taking advantage of the simplicity of the thruster, it should be possible to launch small (10 to 1000 kg) payloads to orbit using roughly 1 MW of average laser power per kg of payload. The incremental cost of such launches would be of an order of $200/kg for the smallest systems, decreasing to essentially the cost of electricity to run the laser (a few times $10/kg) for larger systems. Although the individual payload size would be smaller, a laser launch system would be inherently high-volume, with the capacity to launch tens of thousands of payloads per year. Also, with high exhaust velocity, a laser launch system could launch payloads to high velocities - geosynchronous transfer, Earth escape, or beyond - at a relatively small premium over launches to LEO. The status

of pulsed laser propulsion is briefly reviewed including proposals for advanced vehicles. Several applications appropriate to the early part of the next century and perhaps valuable well into the next millennium are discussed qualitatively: space habitat supply, deep space mission supply, nuclear waste disposal, and manned vehicle launching. DOE

N91-22158*# Analex Corp., Cleveland, OH.
MOMENTUM HARVESTING TECHNIQUES FOR SOLAR SYSTEM TRAVEL
Alan J. Willoughby *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 276-285 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22A

Astronomers are lately estimating there are 400,000 Earth visiting asteroids larger than 100 meters in diameter. These asteroids are accessible sources of building materials, propellants, oxygen, water, and minerals which also constitute a huge momentum reserve, potentially usable for travel throughout the solar system. To use this momentum, these stealthy objects must be tracked and the extraction of the momentum wanted must be learned. Momentum harvesting by momentum transfer from asteroid to spacecraft, and by using the momentum of the extraterrestrial material to help deliver itself to the destination are discussed. A net and tether concept is the suggested means of asteroid capture, the basic momentum exchange process. The energy damping characteristics of the tether will determine the velocity mismatch that can be tolerated, and hence the amount of momentum that can be harvested per capture. As it plays out of its reel, drag on the tether steadily accelerates the spacecraft. A variety of concepts for riding and using the asteroid after capture are discussed. The hitchhiker uses momentum transfer only. The beachcomber, the caveman, the swinger, the prospector, and the rock wrecker also take advantage of raw asteroidal materials. The chemist and the hijacker go further, they process the asteroid into propellant. Or, an 'asteroid railway system' could evolve with each hijacked asteroid becoming a scheduled train. Travelers could board the space railway system assured that water, oxygen, and propellants await them. Author

N91-22159*# Outer Space Environments, Houston, TX.
THE CENTAURI PROJECT: MANNED INTERSTELLAR TRAVEL
Thomas M. Ciesla *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 286-298 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22A

The development of antimatter engines for spacecraft propulsion will allow man to expand to the nearest stellar neighbors such as the Alpha Centuri system. Compared to chemically powered rockets like the Apollo mission class which would take 50,000 years to reach the Centauri system, antimatter propulsion would reduce one way trip time to 30 years or less. The challenges encountered by manned interstellar travel are formidable. The spacecraft must be a combination of sublight speed transportation system and a traveling microplanet serving an expanding population. As the population expands from the initial 100 people to approximately 300, the terraformed asteroid, enclosed by a man-made shell will allow for expansion over its surface in the fashion of a small terrestrial town. All aspects of human life - birth; death; physical, emotional, and educational needs; and government and law must be met by the structure, systems, and institutions on-board. Author

N91-22160*# Analytech, Jonesboro, GA.
SPECULATIONS AND INQUIRIES REGARDING THE POSSIBILITIES FOR AND LIMITATIONS TO PRACTICAL INTERSTELLAR TRAVEL
William W. Gardiner *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 299-306 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22A

The existence of superluminal phenomena have now been independently confirmed by physicists working in several different laboratories, most notably by the team of Alain Aspect in Paris. The two major variants of these experiments are described and their implications for superluminal communication and superluminal travel are discussed. It is noted that while the original suggestion for these experiments is due in part to Albert Einstein (Einstein, Rosen, and Podolsky, 1935), their recent empirical validation presents a significant anomaly within the theoretical framework of the special theory of quantum mechanics. How a newly emerging paradigm broadly encompassing the empirical sciences, and informed by both the social sciences and general systems theory may resolve this theoretical crisis is discussed. With the impasse to further elaboration of these effects for possible superluminal applications removed, the discussion concludes with a research proposal. Author

N91-22161*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EXPLORING THE NOTION OF SPACE COUPLING PROPULSION **c20**
Marc G. Millis *In its* Vision-21: Space Travel for the Next Millennium Apr. 1990 p 307-316 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

All existing methods of space propulsion are based on expelling a reaction mass (propellant) to induce motion. Alternatively, 'space coupling propulsion' refers to speculations about reacting with space-time itself to generate propulsive forces. Conceivably, the resulting increases in payload, range, and velocity would constitute a breakthrough in space propulsion. Such speculations are still considered science fiction for a number of reasons: (1) it appears to violate conservation of momentum; (2) no reactive media appear to exist in space; (3) no 'Grand Uniform Theories' exist to link gravity, an acceleration field, to other phenomena of nature such as electrodynamics. The rationale behind these objectives is the focus of interest. Various methods to either satisfy or explore these issues are presented along with secondary considerations. It is found that it may be useful to consider alternative conventions of science to further explore speculations of space coupling propulsion. Author

N91-22162*# Air Force Flight Dynamics Lab., Wright-Patterson AFB, OH.
ACHIEVABLE SPACE ELEVATORS FOR SPACE TRANSPORTATION AND STARSHIP ACCELERATION **c15**
Jerome Pearson *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 321-329 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22B

Space elevator concepts for low-cost space launches are reviewed. Previous concepts suffered from requirements for ultra-high-strength materials, dynamically unstable systems, or from danger of collision with space debris. The use of magnetic grain streams solves these problems. Magnetic grain streams can support short space elevators for lifting payloads cheaply into Earth orbit, overcoming the material strength problem in building space elevators. Alternatively, the stream could support an international spaceport circling the Earth daily tens of miles above the equator, accessible to advanced aircraft. Mars could be equipped with a similar grain stream, using material from its moons Phobos and Deimos. Grain-stream arcs about the sun could be used for fast launches to the outer planets and for accelerating starships to near lightspeed for interstellar reconnaisance. Grain streams are essentially impervious to collisions, and could reduce the cost of space transportation by an order of magnitude. Author

N91-22163*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
REACTIONLESS PROPULSION USING TETHERS **c20**
Geoffrey A. Landis *In its* Vision-21: Space Travel for the Next Millennium Apr. 1990 p 330-340 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

An orbiting tethered satellite can propel itself by reaction against

the gravitational gradient, with expenditure of energy but with no use of on-board reaction mass. Energy can be added to the orbit by pumping the tether length in the same way as pumping a swing. Examples of tether propulsion in orbit without use of reaction mass are discussed, including: (1) using tether extension to reposition a satellite in orbit without fuel expenditure by extending a mass on the end of a tether; (2) using a tether for eccentricity pumping to add energy to the orbit for boosting an orbital transfer; and (3) length modulation of a spinning tether to transfer angular momentum between the orbit and tether spin, thus allowing changes in orbital angular momentum. Author

N91-22164*# General Atomic Co., San Diego, CA.
EXPLORATION OF PLANETESIMALS BY A TRIPARTITE TETHERED SPACECRAFT
Richard B. Stephens *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 341-345 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22A

Asteroids and comets exert such a small gravitational force that it is not practical to survey them from orbit. One must instead continuously accelerate using maneuvering rockets to move around the surface. A space exploration craft in three parts connected by lightweight cables can survey asteroids and comets, and deploy landers, without requiring the large thrusters and the continuous depletion of fuel required by a single craft. The spacecraft is deployed by spinning up from a compact configuration using low thrust jets, and then maintain surveying orbit without any major expenditure of energy. The triangular tether arrangement is stable, but care must be taken in changing orbits and with deploying and recovering samples, as can be demonstrated with a simple simulation. Even 100 km long tethers occupy a low payload fraction. Author

N91-22165*# Hawaii Univ., Manoa. Dept. of Mechanical Engineering.
ON SPACE-BASED SETI
Willem Stuiver *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 346-350 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22A

Space-based antenna systems for the search of signals from extra-terrestrial intelligence are discussed. Independent studies of the ecliptic solar-sailing transfer problem from the geosynchronous departure orbit to Sun-Earth collinear transterrestrial liberation point were conducted. They were based on a relatively simple mathematical model describing attitude-controlled spacecraft motion in the ecliptic plane as governed by solar and terrestrial gravitational attraction together with the solar radiation pressure. The resulting equations of motion were integrated numerically for a relevant range of values of spacecraft area-to-mass ratio and for an appropriate spacecraft attitude-control law known to lead to Earth escape. Experimentation with varying initial conditions in the departure orbit, and with attitude-control law modification after having achieved Earth escape, established the feasibility of component deployment by means of solar sailing. Details are presented. Author

N91-22166*# NASA Space Station Program Office, Reston, VA.
SPACEPORT OPERATIONS FOR DEEP SPACE MISSIONS
Alan C. Holt *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 351-364 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22A

Space Station Freedom is designed with the capability to cost-effectively evolve into a transportation node which can support manned lunar and Mars missions. To extend a permanent human presence to the outer planets (moon outposts) and to nearby star systems, additional orbiting space infrastructure and great advances in propulsion system and other technologies will be required. To identify primary operations and management requirements for these deep space missions, an interstellar design concept was developed and analyzed. The assembly, test, servicing, logistics resupply, and increment management techniques anticipated for lunar and Mars missions appear to provide a pattern which can be extended in an analogous manner to deep space missions. A long range, space infrastructure development plan (encompassing deep space missions) coupled with energetic, breakthrough level propulsion research should be initiated now to assist in making the best budget and schedule decisions. Author

N91-22167*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MINI-ROVERS FOR MARS EXPLORATIONS **c37**
David P. Miller *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 365-370 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 13F

Rovers are desirable for surface exploration because they allow sampling, and sample returns from several diverse locations on a planet's surface. Unfortunately, the rovers currently being examined for Mars exploration have several undesirable features. These rovers are quite massive (500 kg to one ton), have very complicated operations, and are very expensive. A possible alternative is described to using large rovers for exploring the surface of Mars. The idea of mini-rovers is proposed. Mini-rovers weigh less than 5 kg, are trivial to control from the ground, and can do a more thorough survey of the terrain (per kilogram of mass) than can be obtained by large rovers. By redesigning the Mars sample return mission to accommodate the idea of mini-rovers and small spacecraft, considerable mass and cost savings can be achieved. Author

N91-22168*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ADVANCED SPACECRAFT: WHAT WILL THEY LOOK LIKE AND WHY **c18**
Humphrey W. Price *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 371-390 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22B

The next century of spaceflight will witness an expansion in the physical scale of spacecraft, from the extreme of the microspacecraft to the very large megaspacecraft. This will respectively spawn advances in highly integrated and miniaturized components, and also advances in lightweight structures, space fabrication, and exotic control systems. Challenges are also presented by the advent of advanced propulsion systems, many of which require controlling and directing hot plasma, dissipating large amounts of waste heat, and handling very high radiation sources. Vehicle configuration studies for a number of theses types of advanced spacecraft were performed, and some of them are presented along with the rationale for their physical layouts. Author

N91-22169*# Rockwell International Corp., Downey, CA. Space Transportation Systems Div.
UNUSUAL SPACECRAFT MATERIALS **c18**
Jonathan V. Post *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 391-403 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22B

For particularly innovative space exploration missions, unusual requirements are levied on the structural components of the spacecraft. In many cases, the preferred solution is the utilization of unusual materials. This trend is forecast to continue. Several hypothetic examples are discussed. Author

N91-22170*# University of Southern California, Los Angeles. Inst. of Aerospace Systems Architecture and Technology.
MALEO: MODULAR ASSEMBLY IN LOW EARTH ORBIT. A STRATEGY FOR AN IOC LUNAR BASE
M. Thangavelu and G. G. Schierle *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 404-415 (For primary document see N91-22139

14-12)
Avail: NTIS HC/MF A25 CSCL 22A

Modular Assembly in Low Earth Orbit (MALEO) is a new strategy for building an initial operational capability lunar habitation base. In this strategy, the modular lunar base components are brought up to Low Earth Orbit by the Space Transportation System/Heavy Lift Launch Vehicle fleet, and assembled there to form a complete lunar base. Modular propulsion systems are then used to transport the MALEO lunar base, complete and intact, all the way to the moon. Upon touchdown on the lunar surface, the MALEO lunar habitation base is operational. An exo-skeletal truss superstructure is employed in order to uniformly absorb and distribute the rocket engine thrusting forces incurred by the MALEO lunar base during translunar injection, lunar orbit insertion, and lunar surface touchdown. The components, configuration, and structural aspects of the MALEO lunar base are discussed. Advantages of the MALEO strategy over conventional strategies are pointed out. It is concluded that MALEO holds promise for lunar base deployment. Author

N91-22171*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DESIGN STRATEGIES FOR THE INTERNATIONAL SPACE UNIVERSITY'S VARIABLE GRAVITY RESEARCH FACILITY c14
Sheila G. Bailey, Francis P. Chiaramonte, and Kenneth J. Davidian *In its* Vision-21: Space Travel for the Next Millennium Apr. 1990 p 416-427 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 14B

A variable gravity research facility named 'Newton' was designed by 58 students from 13 countries at the International Space University's 1989 summer session at the Universite Louis Pasteur, Strasbourge, France. The project was comprehensive in scope, including a political and legal foundation for international cooperation, development and financing; technical, science and engineering issues; architectural design; plausible schedules; and operations, crew issues and maintenance. Since log-term exposure to zero gravity is known to be harmful to the human body, the main goal was to design a unique variable gravity research facility which would find a practical solution to this problem, permitting a manned mission to Mars. The facility would not duplicate other space-based facilities and would provide the flexibility for examining a number of gravity levels, including lunar and Martian gravities. Major design alternatives included a truss versus a tether based system which also involved the question of docking while spinning or despinning to dock. These design issues are described. The relative advantages or disadvantages are discussed, including comments on the necessary research and technology development required for each. Author

N91-22172*# Michigan Technological Univ., Houghton. Dept. of Metallurgical and Materials Engineering.
A COMPARISON OF MICROWAVE VERSUS DIRECT SOLAR HEATING FOR LUNAR BRICK PRODUCTION c31
S. J. Yankee, D. G. Strenski, B. J. Pletka, D. S. Patil, and B. C. Mutsuddy *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 428-435 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 13H

Two processing techniques considered suitable for producing bricks from lunar regolith are examined: direct solar heating and microwave heating. An analysis was performed to compare the two processes in terms of the amount of power and time required to fabricate bricks of various sizes. Microwave heating was shown to be significantly faster than solar heating for rapid production of realistic-size bricks. However, the relative simplicity of the solar collector(s) used for the solar furnace compared to the equipment necessary for microwave generation may present an economic tradeoff. Author

N91-22173*# Fielder (Judith), Reston, VA.
A HYDROPONIC DESIGN FOR MICROGRAVITY AND GRAVITY INSTALLATIONS c51
Judith Fielder and Nickolaus Leggett (Leggett, Nickolaus, Reston, VA) *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 436-439 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 06C

A hydroponic system is presented that is designed for use in microgravity or gravity experiments. The system uses a sponge-like growing medium installed in tubular modules. The modules contain the plant roots and manage the flow of the nutrient solution. The physical design and materials considerations are discussed, as are modifications of the basic design for use in microgravity or gravity experiments. The major external environmental requirements are also presented. Author

N91-22174*# North Dakota Univ., Grand Forks. Energy and Environment Research Center.
LOW-TEMPERATURE PLASMA TECHNOLOGY AS PART OF A CLOSED-LOOP RESOURCE MANAGEMENT SYSTEM c75
Melanie D. Hetland, John R. Rindt, Frank A. Jones, and Randal S. Sauer *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 444-459 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 20I

The results of this testing indicate that the agitated low-temperature plasma reactor system successfully converted carbon, hydrogen, and nitrogen into gaseous products at residence times that were about ten times shorter than those achieved by stationary processing. The inorganic matrix present was virtually unchanged by the processing technique. It was concluded that this processing technique is feasible for use as part of a close-looped processing resource management system. Author

N91-22175*# Wake Forest Univ., Winston-Salem, NC. School of Medicine.
CHARACTERIZATION OF BLOOD DRAWN RAPIDLY FOR USE IN BLOOD VOLUME EXPANSION STUDIES: AN ANIMAL MODEL FOR SIMULATED WEIGHTLESSNESS c51
V. Michelle Chenault, Colleen D. Lynch, Mariana Morris, Jill Clodfelter, and Phillip M. Hutchins *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 460-467 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 06C

It was demonstrated that up to 8ml of blood can be drawn from donar rats without significantly increasing volume and stress sensitive hormones, and thus can be used for volume expansion studies. Infusion of whole blood allows more physiological changes that can be seen with volume expansion by saline or other ionic solutions. The infusion of whole blood to induce hypervolemia may provide an improved model to study the fluid balance and control mechanisms operative in weightlessness. Blood samples were drawn as quickly as possible from femoral artery catheters chronically implanted in Sprague Dawley rats and analyzed for hematocrit, plasma sodium, potassium, osmolality, corticosterone, epinepherine, norepinephrine, and vasopressin. The levels were found to be comparable to those of normal rats. Author

N91-22176*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE THEORY OF AN AUTO-RESONANT FIELD EMISSION CATHODE RELATIVISTIC ELECTRON ACCELERATOR FOR HIGH EFFICIENCY MICROWAVE TO DIRECT CURRENT POWER CONVERSION c20
Robert M. Manning *In its* Vision-21: Space Travel for the Next Millennium Apr. 1990 p 468-476 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

A novel method of microwave power conversion to direct current is discussed that relies on a modification of well known resonant linear relativistic electron accelerator techniques. An analysis is

presented that shows how, by establishing a 'slow' electromagnetic field in a waveguide, electrons liberated from an array of field emission cathodes, are resonantly accelerated to several times their rest energy, thus establishing an electric current over a large potential difference. Such an approach is not limited to the relatively low frequencies that characterize the operation of rectennas, and can, with appropriate waveguide and slow wave structure design, be employed in the 300 to 600 GHz range where much smaller transmitting and receiving antennas are needed. Author

N91-22177*# Leggett (Nickolaus), Reston, VA.
NATURAL VACUUM ELECTRONICS c33
Nickolaus Leggett *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 477-484 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 09C

The ambient natural vacuum of space is proposed as a basis for electron valves. Each valve is an electron controlling structure similiar to a vacuum tube that is operated without a vacuum sustaining envelope. The natural vacuum electron valves discussed offer a viable substitute for solid state devices. The natural vacuum valve is highly resistant to ionizing radiation, system generated electromagnetic pulse, current transients, and direct exposure to space conditions. Author

N91-22178*# Spiral Survey Expedition, Thunder Bay (Ontario).
POLAR LUNAR POWER RING: PROPULSION ENERGY RESOURCE c44
Graham Scott Galloway *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 485-493 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 10B

A ring shaped grid of photovoltaic solar collectors encircling a lunar pole at 80 to 85 degrees latitude is proposed as the primary research, development, and construction goal for an initial lunar base. The polar Lunar Power Ring (LPR) is designed to provide continuous electrical power in ever increasing amounts as collectors are added to the ring grid. The LPR can provide electricity for any purpose indefinitely, barring a meteor strike. The associated rail infrastructure and inherently expandable power levels place the LPR as an ideal tool to power an innovative propulsion research facility or a trans-Jovian fleet. The proposed initial output range is 90 Mw to 90 Gw. Author

N91-22179*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
APPLICATIONS OF THIN FILM TECHNOLOGY TOWARD A LOW-MASS SOLAR POWER SATELLITE c76
Geoffrey A. Landis (Sverdrup Technology, Inc., Brook Park, OH.) and Ronald C. Cull *In its* Vision-21: Space Travel for the Next Millennium Apr. 1990 p 494-500 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 20L

Previous concepts for solar power satellites have used conventional-technology photovoltaics and microwave tubes. The authors propose using thin film photovoltaics and an integrated solid state phased array to design an ultra-lightweight solar power satellite, resulting in a potential reduction in weight by a factor of ten to a hundred over conventional concepts for solar power satellites. Author

N91-22180*# Michigan Technological Univ., Houghton. Dept. of Geological Engineering, Geology, and Geophysics.
PLANETARY MATERIALS AND RESOURCE UTILIZATION: AN INTERDISCIPLINARY ENGINEERING DESIGN COURSE AT MICHIGAN TECHNOLOGICAL UNIVERSITY
W. I. Rose, J. B. Paces, C. A. Chesner, B. J. Pletka, A. Hellawell, S. K. Kawatra, and J. E. Pilling *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 501-508 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22A

A new course was developed and instituted in the spring quarter of 1989 dealing with topics related to space resource utilization and related engineering. The course development required a concerted, coordinated effort, because a similar course which might be used as a guide could not be identified anywhere and the interdisciplinary perspective that was required was not identified anywhere on the university campus. Students in the class worked on interdisciplinary design projects which culminated in papers and oral presentations. Each of the six design groups consisted of several engineers with different disciplinary roots. The entire course lecture sequence, about 50 hours in all, was videotaped. Discussed here are the authors' experiences in developing the course, including the course syllabus and speaker list. Author

N91-22181*# Tokyo Univ., Sagamihara (Japan). Inst. of Space and Astronautical Science.
ANTIMATTER APPLIED FOR EARTH PROTECTION FROM ASTEROID COLLISION
Shin Satori, Hitoshi Kuninaka, and Kyoichi Kuriki *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 509-524 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22A

An Earth protection system against asteroids and meteorites in colliding orbit is proposed. The system consists of detection and deorbiting systems. Analyses are given for the resolution of microwave optics, the detectability of radar, the orbital plan of intercepting operation, and the antimatter mass require for totally or partially blasting the asteroid. Antimatter of 1 kg is required for deorbiting an asteroid 200 m in diameter. An experimental simulation of antimatter cooling and storage is planned. The facility under construction is discussed. Author

N91-22182*# Advisory Committee on the Future of the US Space Program, Washington, DC.
REPORT OF THE ADVISORY COMMITTEE ON THE FUTURE OF THE US SPACE PROGRAM
Dec. 1990 63 p Prepared for NASA, Washington Original contains color illustrations
(NASA-TM-104952; NAS 1.15:104952) Avail: NTIS HC/MF A04; 13 functional color pages CSCL 22A

The United States' civil space program was rather hurriedly formulated some three decades ago on the heels of the successful launch of the Soviet Sputnik. A dozen humans have been placed on the Moon and safely returned to Earth, seven of the other eight planets have been viewed at close range, including the soft landing of two robot spacecraft on Mars, and a variety of significant astronomical and other scientific observations have been accomplished. Closer to Earth, a network of communications satellites has been established, weather and ocean conditions are now monitored and reported as they occur, and the Earth's surface is observed from space to study natural resources and detect sources of pollution. Problems and perspectives of the program are given as seen by the committee. The committee finds that there are nine concerns about the space program which are deserving of attention. The responsibilities of the agency are given. The space agenda becomes one of what can and should the U.S. afford for its space program. Also given is a concept of what the committee believes is a balanced space program. The programs international role is defined and some final observations and recommendations are made. Author

N91-22183*# National Aeronautics and Space Administration, Washington, DC.
SPACE PHYSICS MISSIONS HANDBOOK
Robert A. Cooper, comp., David H. Burks, comp. (Science Applications International Corp., Washington, DC.), and Julie A. Hayne, ed. Feb. 1991 299 p
(Contract NASw-4394)
(NASA-TM-104941; NAS 1.15:104941) Avail: NTIS HC/MF A13 CSCL 22A

The purpose of this handbook is to provide background data on current, approved, and planned missions, including a summary of the recommended candidate future missions. Topics include

the space physics mission plan, operational spacecraft, and details of such approved missions as the Tethered Satellite System, the Solar and Heliospheric Observatory, and the Atmospheric Laboratory for Applications and Science. Author

N91-22184# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
SIX DIMENSIONAL TRAJECTORY SOLVER FOR AUTONOMOUS PROXIMITY OPERATIONS M.S. Thesis
Ronald J. Simmons May 1990 73 p
(AD-A231993; AFIT/CI/CIA-90-123) Avail: NTIS HC/MF A04
CSCL 22/3

Many future space mission will require that proximity operations be accomplished reliably, precisely and efficiently without a pilot in the loop. This thesis examines one element of an autonomous proximity operations controller, the trajectory planner. The trajectory planner uses a modified gradient search to find a locally optimal trajectory from the initial state to the target state that does not violate any of the mission constraints. The mission constraints are defined as the maximum time of flight for the operation, the maximum closing velocity allowed, and the obstacles in close proximity to the chase and target craft. The obstacles in this space are not assumed to be stationary; therefore, the planner must be able to develop a solution that, although not guaranteed globally optimal, meets all mission constraints in real time. This will enable the autonomous controller to avoid obstacles moving rapidly with respect to it and to correct for failed actuators. The Clohessy-Wiltshire equations for relative position and quaternions for relative attitude are used to define a state space relationship solver the initial state and the final state as a function of time. The trajectory between then uses these equations to find the minimum fuel solution to the problem of maneuvering to a target position and attitude while evading moving obstacles. Example results and simulations are included for various initial conditions and maneuvering constraints. GRA

N91-22225# Computer Resources International A/S (Denmark).
PLANERS-1: TOWARDS A NEW GENERATION OF MISSION PLANNING SYSTEMS
Jens J. Fuchs, Andre Gasquet, and Ken Currie (Edinburgh Univ., Scotland) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 213-220 (For primary document see N91-22189 14-17)
(Contract ESTEC-8122/88/NL/MAC)
Copyright Avail: NTIS HC/MF A99

N91-22226# Logica Ltd., London (England).
MISSION PLANNING SYSTEMS FOR SCIENTIFIC AND REMOTE SENSING SATELLITES: A COMPARATIVE ANALYSIS
C. R. Haddow, K. O. Roeska, and Erik Mose Soerensen (European Space Agency. European Space Operations Center, Darmstadt, Germany, F.R.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 221-227 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22228# Academy of Sciences (USSR), Moscow. Inst. of Space Research.
LONG-TERM AND SHORT-TERM PLANNING OF X RAY AND GAMMA OBSERVATIONS ON BOARD THE EARTH SATELLITES
R. R. Nazirov, E. E. Ryazanova, A. Zukhanov, and N. G. Khavenson *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 237-239 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22231# Centre National d'Etudes Spatiales, Toulouse (France).
SPOT IMAGE ORGANIZATION [PLANIFICATION DES PRISES DE VUE SPOT]
C. Bastien-Thiry *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 253-257 In FRENCH (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22232# Computer Anwendung fuer Management G.m.b.H., Munich (Germany, F.R.).
ROSAT MISSION PLANNING
D. Garton and H. Frank (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, Germany, F.R.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 259-262 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22238# Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (Germany, F.R.).
MARS: A GENERIC MISSION PLANNING TOOL
A. Kellner, N. Schielow, and F. Zapp *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 297-303 Prepared in cooperation with Erno Raumfahrttechnik G.m.b.H. (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22244# Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (Germany, F.R.). Space Systems Group.
COLUMBUS GENERIC ELEMENT MANAGEMENT AND PLANNING CONCEPT
J. Sved and H. Luttmann *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 337-342 Previously announced as N91-12742 Prepared in cooperation with Erno Raumfahrttechnik G.m.b.H. (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22258# Intecs Sistemi S.p.A., Rome (Italy).
ESSOPE: EXPERT SYSTEM FOR SPACECRAFT OPERATIONS PLANNING AND EXECUTION
S. Gusmeroli, A. Pezzinga, S. Barone, D. Briatico, and Joe Wheadon (European Space Agency. European Space Operations Center, Darmstadt, Germany, F.R.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 431-436 Prepared for Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Milan (For primary document see N91-22189 14-17)
(Contract ESA-8186/89/D/IM(SC))
Copyright Avail: NTIS HC/MF A99

13 ASTRODYNAMICS

Includes powered and free-flight trajectories; and orbital and launching dynamics.

N91-22185 Stanford Univ., CA.
MINIMUM FUEL TRAJECTORIES FOR LOW-THRUST POWER-LIMITED SPACECRAFT Ph.D. Thesis
Oded M. Golan 1990 93 p
Avail: Univ. Microfilms Order No. DA9102267

Minimum fuel trajectories for low-thrust power-limited spacecraft are investigated. The Pole Squatter mission involves an orbit transfer in Earth's gravity field. Edelbaum's orbit averaging method is used and Marec's analytical solution for the co-latus rectum transfer, as well as the numerically obtained globally optimal transfer are studied. In a mission to Lagrange points L(sub 4) and L(sub 5) Moon's perturbations must be considered. A numerical iterative procedure is started using an analytical approximation for a nearly circular spiral. Optimal Earth-Moon transfer is obtained by patching Earth and Moon spirals on the sphere of influence. The solution of the previous problem serves as a starting point for the iterative procedure. Typical results for the trajectories and for the thrust acceleration variations during the transfer are shown. Dissert. Abstr.

N91-22311*# Illinois Univ., Chicago. Dept. of Mathematics, Statistics, and Computer Science.
QUERYING DATABASES OF TRAJECTORIES OF DIFFERENTIAL EQUATIONS 2: INDEX FUNCTIONS
Robert Grossman *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 35-39 Sponsored in part by Laboratory for Advanced Computing (For primary document see N91-22307 14-18)
(Grants NAG2-513; NSF DMS-89-04740)
Avail: NTIS HC/MF A20 CSCL 22A

14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air).*

N91-22186# Utah State Univ., Logan. Center for Atmospheric and Space Sciences.
CHARGE-2B ELECTRON GUN SYSTEM Final Report, Aug. 1986 - Sep. 1989
N. B. Myers, A. B. White, L. Olsen, and W. J. Raitt Nov. 1990 27 p
(Contract MIPR-88-00037; AF Proj. 2305)
(AD-A231514; RADC-TR-90-267) Avail: NTIS HC/MF A03 CSCL 09/1

An extremely versatile, modulated electron gun (MEG) system has been designed, fabricated and tested. The Herrmannsfeldt electron optics computer simulation code was used to great advantage during the design. The code was subsequently validated to high accuracy during hardware testing. A ground fault interruptable high voltage battery stack has been developed, which will greatly enhance system reliability during flight. MEG laboratory performance test results are discussed, along with the performance diagnostics to be flown together with the MEG on the upcoming CHARGE-2B sounding rocket mission. GRA

N91-22171*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DESIGN STRATEGIES FOR THE INTERNATIONAL SPACE UNIVERSITY'S VARIABLE GRAVITY RESEARCH FACILITY
Sheila G. Bailey, Francis P. Chiaramonte, and Kenneth J. Davidian *In its* Vision-21: Space Travel for the Next Millennium Apr. 1990 p 416-427 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 14B

15 LAUNCH VEHICLES AND SPACE VEHICLES

Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles.

For related information see also *20 Spacecraft Propulsion and Power.*

N91-22187# Bristol Univ. (England). Dept. of Aerospace Engineering.
RECOVERY AND REUSE OF A ROCKET LAUNCHER B.S. Thesis
J. E. Simpson and A. N. Wombwell Jun. 1990 189 p
(BU-518; ETN-91-99211) Avail: NTIS HC/MF A09

A typical launch cost of an Ariane 5 is 150 million dollars. This is inacceptable if the utilization of space is to be embarked upon to any great extent. The feasibility and economics of making the Ariane 5 expendable launcher reusable is investigated. Ballistic and winged recovery were considered and it was found that, with the cost models provided, the latter option gave a substantial increase in the incurred costs. However ballistic recovery from the sea would mean a saving of 1.6 pct. on the launch costs. This result is encouraging, but it is felt that any setback within the recovery program would considerably overshadow this figure. It is therefore concluded that the launch cost can be reduced by 2.4 million dollars by using parachute recoverable solid rocket boosters, cryogenic first stage and vehicle equipment bay-L5 composite. Unfortunately the reliability of reuse was not touched upon and hence recovery could prove costly with respect to pure expendibility. A third year project looking into this aspect of reuse is therefore recommended. ESA

N91-22152*# Physical Sciences, Inc., Andover, MA.
LASER DRIVEN LAUNCH VEHICLES FOR CONTINUOUS ACCESS TO SPACE
C. J. Rollins, A. Bailey, A. Gelb, M. Gauthier, C. Goldey, E. Lo, D. Resendes, D. Rosen, and G. Weyl *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 193-201 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22B

N91-22156*# Rensselaer Polytechnic Inst., Troy, NY.
LASER-BOOSTED LIGHTCRAFT TECHNOLOGY DEMONSTRATOR
J. C. Richard, C. Morales, W. L. Smith, and L. N. Myrabo *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 252-264 Previously announced in IAA as A89-54360 Sponsored in part by Lawrence Livermore National Lab., CA (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22B

N91-22162*# Air Force Flight Dynamics Lab., Wright-Patterson AFB, OH.
ACHIEVABLE SPACE ELEVATORS FOR SPACE TRANSPORTATION AND STARSHIP ACCELERATION
Jerome Pearson *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 321-329 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22B

16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques.

For related information see also *03 Air Transportation and Safety* and *18 Spacecraft Design, Testing and Performance.* For space suits see *54 Man/System Technology and Life Support.*

N91-22188# Bristol Univ. (England). Dept. of Aerospace Engineering.
SPACE TUG: AN ORBITAL TRANSFER VEHICLE B.S. Thesis
J. L. Muir and C. Murmann Jun. 1990 73 p
(BU-513; ETN-91-99206) Avail: NTIS HC/MF A04

The mission specification for this first order study of an Orbital Transfer Vehicle (OTV) was the capability to transport a two ton satellite (based on the Intelsat 4 design) between geostationary orbit and low Earth orbit. The OTV would rendezvous with the Space Transportation System (or equivalent) and with the Space Station. To minimize the mission cost, a low fuel requirement was a priority. Thus, orbital transfer was planned via the Hohmann minimum energy transfer ellipse, with an 'aerobraking maneuver' assist on the return journey. This was found to be the most fuel efficient. Apart from the new technologies involved with aerobreaking, design policy was conservative, using tried and tested materials and systems. The results outline a suggested format for an OTV and identify some of the main design problems faced, namely the saving of weight to reduce fuel requirements and the simulation of the complex flowfield during aerobraking. ESA

17 SPACE COMM., SPACECRAFT COMM., COMMAND & TRACKING

Includes telemetry; space communications networks; astronavigation and guidance; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

N91-22189# European Space Agency, Paris (France).
GROUND DATA SYSTEMS FOR SPACECRAFT CONTROL
W. R. Burke, comp. Oct. 1990 682 p In ENGLISH and FRENCH Symposium held in Darmstadt, Fed. Republic of Germany, 26-29 Jun. 1990
(ESA-SP-308; ISBN-92-9092-074-2; ISSN-0379-6566; ETN-91-99263) Copyright Avail: NTIS HC/MF A99

Control system architectures involved in telemetry and telecommand structures are discussed. The use of packet transmission as a means of coping with increasing levels of onboard automation and autonomy is reviewed. The software aspects of control station equipment and the networks connecting stations and control centers are examined. Mission management systems designed to cover the planning and optimization aspects of all the resources involved in space missions are studied. Mission management requirements from scientific, Earth observation and telecommunication missions are analyzed in terms of long, medium and short term planning aspects. For individual titles, see N91-22190 through N91-22301.

N91-22190# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE ARCHITECT'S FRAMEWORK FOR GROUND DATA SYSTEM DEVELOPMENT IN THE 1990'S
M. M. Ebersole *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 3-6 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

The architect's framework which will describe the myriad of trends and practical conditions that influence the data system architect's design choices in developing the data systems architectures of the 1990's is discussed. The architectural choices are influenced by mission trends, information systems trends, technology trends and practical considerations such as available resources and schedules. These considerations, which will determine architectural choices, are described. A set of guidelines is presented for consideration, based on the recent experience of the author in developing a large scale, distributed system for spacecraft control. ESA

N91-22191# Science Systems Ltd., Bristol (England).
A HIGH AVAILABILITY CONTROL SYSTEM ARCHITECTURE
C. A. Butcher *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 7-13 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

A modular high availability, multisatellite ground control computer system, based on the Kernel system, known as the Modular Spacecraft Control System (MSCS) is described. Currently delivered configurations range from a single datastream stand alone system to a fully dual redundant eight datastream system. The basic architecture of the system allows the flexible configuration of modular software and hardware components to provide the required functionality, performance and availability with low cost of ownership. ESA

N91-22192# Logica Ltd., Cobham (England).
THE DESIGN OF THE GROUND SEGMENT TO PROVIDE OPTIMUM SERVICE AT MINIMUM COST
R. J. Peberdy and M. Calvo (Eutelsat, Paris, France) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 15-21 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

Larger and more complex payloads will inevitably lead to increased cost in their operation unless sensible design allows such costs to be kept within viable limits. The operating cost of the satellite control must be addressed from the start, and ground support facilities provided with the minimum infrastructure and manpower, but with optimum availability and reliability. The Eutelsat system, procured to meet these criteria is discussed. Off the shelf equipment, provided at two ground stations and the Satellite Control Centre (SCC), is of well tried and proven design leading to a very high level of reliability. Computer programs based on those developed over many years at the European Space Operations Centre (ESOC) are discussed. Computer redundancy is achieved by dual facilities at the SCC, and a standby SCC at the Rambouillet Earth station. Single, multiwindow, icon driven displays with advanced colour graphics and print facilities, are provided for ground control operations. ESA

N91-22193*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A DISTRIBUTED COMPUTER ENVIRONMENT FOR A MULTIMISSION SPACECRAFT OPERATIONS AND CONTROL CENTER
A. J. Gainsborough, J. A. Holladay, and P. H. Ray *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 23-28 Sponsored by NASA, Washington (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99 CSCL 09F

The Space Flight Operations Center (SFOC) at the Jet Propulsion Laboratoy (JPL), a new multimission ground data system is described. The SFOC design begins with a baseline system that supplies the common set of support functions for flight operations and control. Low cost adaptations to this baseline, with any mission specific additions, are made for each mission. The distributed SFOC architecture is comprised of a multi-layered set of software subsystems that provide a core set of functions that are common to the application subsystems. When the SFOC Project is completed in 1992, the SFOC will support the Voyager, Galileo, Ulysses, Magellan, and Mars Observer deep space missions. ESA

N91-22194# European Space Agency. European Space Operations Center, Darmstadt (Germany, F.R.).
THE SCOS: A CONFIGURABLE INFRASTRUCTURE FOR THE CONTROL OF SPACECRAFT USING PACKETS
Bruno Mullet, J. F. Kaufeler, J. Bowers, and M. Ahier (Logica Ltd., London, England) *In its* Ground Data Systems for Spacecraft Control Oct. 1990 p 29-35 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

The reusable and highly configurable Spacecraft Control System (SCOS) kernel is described. The objectives of the SCOS are to provide the telemetry and telecommand related functions for both classical and new packetized spacecraft data and for low orbiting, geostationary and deep space missions. The telemetry functions include real time reception, validation, processing and filing of telemetry, real time and retrieval displays, printouts, archiving, etc. The telecommand functions include the preparation of telecommands, scheduling, validation, verification, filling, display, and printouts. ESA

N91-22195*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
FLIGHT MISSION CONTROL FOR MULTIPLE SPACECRAFT
Robert E. Ryan *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 37-41 Sponsored by NASA, Washington (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99 CSCL 09F

A plan developed by the Jet Propulsion Laboratory for mission control of unmanned spacecraft is outlined. A technical matrix organization from which, in the past, project teams were formed to uniquely support a mission is replaced in this new plan. A cost effective approach was needed to make best use of limited resources. Mission control is a focal point operations and a good place to start a multimission concept. Co-location and sharing common functions are the keys to obtaining efficiencies at minimum

additional risk. For the projects, the major changes are sharing a common operations area and having indirect control of personnel. The plan identifies the still direct link for the mission control functions. Training is a major element in this plan. Personnel are qualified for a position and certified for a mission. This concept is more easily accepted by new missions than the ongoing missions. ESA

N91-22196# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
TELECOMMAND SOFTWARE FOR THE BRAZILIAN COMPLETE SPACE MISSION
Wilson Yamaguti and Marcos Antonio CardosoCruz *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 43-47 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

The telecommand software of the satellite control system for the Brazilian complete space mission is described. The telecommand software runs in a VAX/VMS environment and it has facilities to generate the satellite basic command and command sequence files, to deliver a command, to manage the command transmission, to display the command history files and to display the command test data messages. The telecommand software architecture and its interface with other subsystems are described and discussed. The issues related to the implementation aspects and test strategies are presented. The telecommand software is fully based on configuration tables that makes it mission independent. The multimission evolution and workstation environment are discussed. ESA

N91-22197# Logica Ltd., London (England).
THE HIPPARCOS DEDICATED CONTROL SYSTEM: A CASE STUUDY OF A HIGH RELIABILITY SCIENTIFIC SPACECRAFT CONTROL SYSTEM
J. Harborne and Nigel C. Head (European Space Agency. European Space Operations Center, Darmstadt, Germany, F.R.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 51-55 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

The Hipparcos satellite, launched on 8 Aug. 1989 is described. The Hipparcos mission was planned to prepare catalogues of the position of stars to accuracies at the milliarc second level. In order to achieve this ambitious aim, a continuous uplink of instructions to the payload is necessary. This imposes severe availability and continuity requirements. The effect of these reliability requirements in the ground control system is discussed. The failure of the apogee boost motor firing had the consequence that the geostationary orbit could not be reached. Modifications to the ground control system to accommodate the recovery mission are described. Preliminary figures on availability and continuity since the start of the mission are given which demonstrate how the requirements are being met. ESA

N91-22198# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
TELEMETRY PROCESSING AND DISPLAYING SOFTWARE FOR THE BRAZILIAN COMPLETE SPACE MISSION
S. Luciana Seda CardosoGonncalves, Jose Antonio GoncavesPereira, Paulo Cesar deSouzaLucas, and Rubens CruzGatto *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 57-61 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

The telemetry processing and displaying software of the satellite control system for the Brazilian complete space mission is described. The telemetry message is received in a SDID format from an X25 data communication network. The raw data processing is based on configuration tables. The operator can visualize either the processed real time telemetry or the telemetry data from the telemetry history file in three predefined kinds of telemetry page formats and in an out of limit page. The software improvement by using the VT340 terminal double pages facility and workstation environment are discussed. The telemetry processing and displaying software is fully based on configuration tables that makes it independent of the mission. ESA

N91-22199# Computer Anwendung fuer Management G.m.b.H., Munich (Germany, F.R.). Technical/Scientific Div.
AN AUTOMATED SPACECRAFT CONTROL IMPLEMENTATION FOR USINGEN (FED. REPUBLIC OF GERMANY) SCC
Wolfgang Geese *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 63-68 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

A control center with both distributed computing power and a high level availability and reliability is described. The software and hardware systems are designed for three satellites but the entire complex is easily extendable for up to six satellites. Interesting hardware system features include the use of a dual local area network system, VAX cluster with volume shadowing, and VAX workstation with high resolution man/machine interfaces. Innovative software features allow routine operation to be done by utilizing prewritten sequences which can be inserted into the system by using an integrated scheduling system. Encoding of the sequences is achieved via a command language and compiler. The compiler generates an object file or 'sequence'. These can be bound at runtime to other sequences using linkage verification rules. The runtime system interpretively executes the sequences and provides an interface to telemetry, station monitoring and command subsystems to the end operator (able to 'abort' or 'confirm' at all times). Control algorithms in such a language are concluded to be much safer than hard coded alternatives. ESA

N91-22200# Fujitsu Ltd., Tokyo (Japan).
A NEW GROUND DATA SYSTEM FOR AKEBONO (EXOS-D) SATELLITE
S. Awatake, M. Kurihara, T. Tohchi, M. Moriya, M. Kojima, H. Ohsawa, and N. Nishigori *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 69-74 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

The ground data system for Akebono (EXOS-D), a scientific satellite launched by the Institute of Space and Astronautical Science (ISAS) last year is described. A real time remote operation of Akenebo at Sagamihara Satellite Operation Center (SSOC) in Kanagawa Prefecture, about 1000 km away from the Japan Kagoshima Space Center (JKSC) is described. A high speed real time data transmission system between JKSC and SSOC is described. Two systems assisting the efficient operation at SSOC, a telemetry data quick look analysis system, and an Operation Program (OP) editing system to control a Data Handling Unit (DHU) are outlined. The AAEBONO telemetry data whose total volume is expected to exceed 300 GB is stored in a database using optical disks. This enables the scientists to access telemetry data efficiently and easily. ESA

N91-22201*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE TOPEX GROUND DATA SYSTEM
Anil K. Agrawal and Alvin M. Willems *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 75-80 Sponsored by NASA, Washington (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

Topex/Poseidon, a dedicated altimetry mission that introduces major advances in measurement accuracy using state of the art dual frequency radar altimeters is described. A radiometer for correction of the altimeter measurements, and high accuracy satellite orbit determination systems, is presented. The functions and the architecture of the proposed ground data system at the Jet Propulsion Laboratory (U.S.) to support the mission are described. ESA

N91-22202# CISI Ingenierie, Toulouse (France).
MERCATOR: A DISTRIBUTED GROUND CONTROL SYSTEM FOR GEOSTATIONARY SATELLITE POSITIONING c61
P. Vielcanet, P. Moran, and H. Secretan (Centre National d'Etudes Spatiales, Toulouse, France) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 81-86 (For primary document see N91-22189 14-17)
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The main design drivers for the development of the MERCATOR (Methods and Realization for the Control of the Altitude and the Orbit of Spacecrafts) system are described. The hardware and software distributed architecture is detailed with emphasis on the Unix based software organization (near real time and offline execution). The development and the various stages of the qualification process are outlined. ESA

N91-22203# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
SATELLITE CONTROL SYSTEM NUCLEUS FOR THE BRAZILIAN COMPLETE SPACE MISSION
Wilson Yamaguti, Anastacio Emanuel deCarvalhoVieira, Julia Leocadia deOliveira, Paulo Eduardo Cardoso, and Petronio Osorio daCosta *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 87-90 (For primary document see N91-22189 14-17)
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The nucleus of the satellite control system for the Brazilian data collecting and remote sensing satellites is described. The system is based on Digital Equipment Computers and the VAX/VMS operating system. The nucleus provides the access control, the system configuration, the event management, history files management, time synchronization, wall display control, and X25 data communication network access facilities. The architecture of the nucleus and its main implementation aspects are described. The implementation experience acquired is considered. ESA

N91-22204# Telespazio, S.p.A., Rome (Italy).
THE ARCHITECTURE OF THE SAX-OCC: A CONTROL CENTRE FOR A SCIENTIFIC SATELLITE
M. Manca, A. Appolloni, and B. Negri (Italian Space Agency, Rome.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 93-96 (For primary document see N91-22189 14-17)
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An overview of the SAX (Satellite for Astronomy in X-rays) mission and a description of the ground OCC (Operational Control Center) is presented. SAX-OCC hardware and software architecture is presented with particular respect to those elements which characterize this center. The SAX-OCC is designed taking into account two different needs. The first one is classical for a control center and is the satellite and ground station monitor and control functionality while the second need is derived from a set of functionalities which are more specific and are strictly related to the scientific nature of the SAX mission. The combination of these needs leads to the development of a hardware configuration which is more powerful than one normally conceived for a geostationay communication satellite control center. ESA

N91-22205# SAT Control, Labege (France).
HERMES FLIGHT CONTROL CENTER: DEFINITION STATUS
Pierre Letalle *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 97-99 (For primary document see N91-22189 14-17)
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The Hermes Flight Control Center (HFCC) located in Toulouse (France) is described. The center is the third in the world after the American center in Houston and the Soviet center in Kaliningrad. All the Hermes elements, both on board and on the ground will be coordinated by the HFCC for all phases of each mission. Aspects of the detailed definition phase still in the requirements analysis subphase are described. Diagrams are used to illustrate the interplay between the different systems. ESA

N91-22206# MATRA Espace, Toulouse (France).
ROLE AND INTEREST OF NEW TECHNOLOGIES IN DATA PROCESSING FOR SPACE CONTROL CENTERS
Jean-Paul Denier, Raoul Caspar, Mario Borillo, and Jean-Luc Soubie (Centre National de la Recherche Scientifique, Toulouse, France) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 101-105 (For primary document see N91-22189 14-17)
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The ways in which a multidisplinary approach will improve space control centers is discussed. Electronic documentation, ergonomics of human computer interfaces, natural language, intelligent tutoring systems and artificial intelligence systems are considered and applied in the study of the Hermes flight control center. It is concluded that such technologies are best integrated into a classical operational environment rather than taking a revolutionary approach which would involve a global modification of the system. ESA

N91-22207# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
SATELLITE CONTROL CENTER FOR 2000 AND BEYOND
Anil K. Agrawal, John D. Bost, and Patricia K. Mangan (Aerospace Corp., El Segundo, CA.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 107-113 (For primary document see N91-22189 14-17)
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A realistic blueprint for satellite control centers through the next decade is presented. Several prototype expert system workstations, knowledge based systems and multimedia systems planned to be an integral part of the future satellite control center are outlined. High speed computers, large mass storage devices and rapid advances in the electronics industry are predicted to lead to massive changes in satellite control centers. In many cases, appropriate command sequences could be automatically generated and triggered to take appropriate corrective action. ESA

N91-22208# Compagnia Italiana Servizi Tecnici, Rome. Space Div.
FUTURE MISSION CONTROL CENTER: AN OPERATIVE SCENARIO
Federico Cavaliere and Silvano Manganelli *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 115-120 (For primary document see N91-22189 14-17)
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Continuous improvement in subsystem design and implementation of new technologies is paving the way to a new generation of unmanned spacecrafts, which will evolve more and more into autonomous systems. Autonomy characteristics cannot cope with the current philosophy of Mission Control Center (MCC) operations, which is based on a more or less unique definition of a 'nominal status', any deviation from which has to be evaluated and managed by the human expert. The current concept of the characteristics of a future generation of spacecraft defining functional characteristics of a mission control center for future unmanned space missions is discussed. ESA

N91-22209# European Space Agency. European Space Operations Center, Darmstadt (Germany, F.R.).
EVOLUTION OF THE IOI OPERATIONS CONCEPT AND OF THE RELATED COMMUNICATIONS ARCHITECTURE BETWEEN CONTROL FACILITIES
U. Christ, W. Frank, and N. Gargir *In its* Ground Data Systems for Spacecraft Control Oct. 1990 p 121-126 (For primary document see N91-22189 14-17)
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A technical approach for the desired decentralized control of the IOI (In Orbit Infrastructure) flight elements is described. A Central Mission Control Center (CMCC) at ESOC is linked via a wide area (public) communications network to the decentralized control and utilization facilities in Europe and the United States. A number of technical details are studied under a system architect

support contract with emphasis on communications and operations issues. A first summary on what has been achieved since and how the future work will be performed is presented. ESA

N91-22210# National Space Development Agency, Tokyo (Japan).
JEM GROUND CONTROL SYSTEM
Yoshiyuki Hasegawa, Yasushi Horikawa, and Akira Tanaka *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 127-130 (For primary document see N91-22189 14-17)
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The Japanese Experimental Module (JEM) to be launched by the Space Transportation System (STS), attached to the Space Station, and activated and verified in-orbit is described. JEM will be utilized internationally as a multipurpose laboratory. While NASA is the focal point for the Space Station systems operation, NASDA is planning to establish a ground control system at Tsukuba Space Center/(TKSC) as a single point of contact with NASA systems to integrate Japanese technical expertise. To support JEM system and Japanese payload operations, NASDA will develop the JEM Operations Center at TKSC. The JEM Operation Center will have management and integration, flight control, payload operation control, engineering support, user support, and logistics support capabilities. ESA

N91-22211# Royal Aerospace Establishment, Farnborough (England).
ESA POLAR PLATFORM GROUND SEGMENT: AN ANGLO-NORWEGIAN PERSPECTIVE
E. B. Davies and S. Howes (Logica Ltd., Cobham, England) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 131-136 (For primary document see N91-22189 14-17)
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The ESA Polar Platform program designed to provide continuity of remotely sensed data after the ERS-1 and ERS-2 missions is described. A series of expendable platforms will provide flight opportunities for a large number and variety of instrument types. These will support users in meteorological, Earth observations, space science and environmental monitoring applications. A key element of the Polar Platform system will be the ground segment. One challenge for this will be the short turnaround time required for compiling payload operational schedules and delivering data and information to users. This will be coupled with the need to manage and coordinate much larger volumes of data both onboard the Platform, via downlinks and through the ground network. Ways to achieve this in an international, multidisciplinary and operational environment are outlined. The British National Space Centre and Norwegian Space Center share a strong interest in Earth observation and space science. They are keen to ensure a Platform ground segment which will satisfy user requirments and have supported industrial studies to this end. The importance of determining user requirements and determining how these can be satisfied by the overall ground architecture is discussed. ESA

N91-22212# European Space Agency. European Space Operations Center, Darmstadt (Germany, F.R.).
KEYNOTE TO THE SESSION ON COMMUNICATIONS, NETWORK, AND STATION CONTROL
Hans K. Uhrig *In its* Ground Data Systems for Spacecraft Control Oct. 1990 p 139-144 (For primary document see N91-22189 14-17)
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The following keynotes to the session on communications, network, and station control want to highlight the evolution of the ground station communication networks used in support of spacecraft to an Integrated Ground Segment Communications Network (IGSCN). The interworking of the IGSCs of the various agencies is outlined, and the IGSCN is described. An IGSCN is the collection of all ground stations and ground to ground communication networks of an agency, which provide a unified communication service between spacecraft and their control centers, payload users, etc. In particular, it provides one common management entity for all its services. ESA

N91-22213# Eutelsat, Paris (France).
SATELLITE/CONTROL CENTRE INTERFACE ORGANISATION IN THE EUTELSAT 2 SATELLITE CONTROL SYSTEM
G. Constantinou and D. Roberts (Logica Ltd., London, England) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 145-150 (For primary document see N91-22189 14-17)
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Eutelsat has established a complete ground segment infrastructure to support the Telemetry, Command, and Ranging (TCR) operations for their second generation of geostationary communication satellites. The TCR system is designed to monitor and control simultaneously up to six Eutelsat 2 satellites in-orbit with maximum reliability and efficiency. An overview of the TCR ground sations is described. The monitoring and control philosophy for these stations is described, and the contributions to system availability and the efficiency of operations at the Satellite Control Center (SCC) yielded by the adopted approach are identified. ESA

N91-22214# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
THE ANTENNA MANAGER SOFTWARE FOR THE BRAZILIAN SATELLITE: IMPLEMENTATION AND STUDY **c61**
Maria deFatimaMattielloFrancisco, Ana Maria Ambrioso (Sociedade Civil de Educacao Bras Cubas, Mogi das Cruzes, Brazil), and Mario Jose C. Ciurra *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 151-156 (For primary document see N91-22189 14-17)
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The design and implementation of the antenna manager software, defined to acquire the first Brazilian satellite from the horizon, track, and re-acquire it after silent zones, are discussed. Strategies are defined to cover the satellite passes. They consist of pointing the antenna, commanding the execution of the telemetry traffic control station uplink frequency sweep, sending a telecommand to turn on the on board transmitter, and accepting commands from operator. This problem is solved by using a finite state automata implemented in a VAX-FORTRAN language through a decision table. The advantage of this design is the use of a table for handling events, which allows the reutilization of the software for other missions by implementing changes in the decision table. Results of the study of the method applied to this software are presented. The results show another way to analyze and solve the same problem. ESA

N91-22215# Marcol Computer Systems Ltd., Darmstadt (Germany, F.R.).
PRODIS: STATION AND PRODUCT GENERATION CONTROL FOR ERS-1
A. Crowson *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 157-161 (For primary document see N91-22189 14-17)
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The first European Remote Sensing Satellite (ERS-1) is the world's first fully integrated remote sensing system in that all activities performed on board and on the ground, up to data product delivery to the user, are an integral part of the ERS-1 system. This necessarily involves an advanced and dedicated ground segment, the monitor and control of which require full integration with the spacecraft mission control itself. The Product Dissemination (PRODIS) Facility, which collects satellite instrument data, produces output products for rapid distribution, disseminates them, and forwards the recorded raw instrument data to processing and archiving facilities, is described. Attempts to handle the principle ground station using a spacecraft control system, as though it were an independent spacecraft itself, are described. This was successful to a great extent and provides a possible option for consideration by future projects. ESA

N91-22216# Societe d'Etudes des Systemes d'Automation, Toulouse (France).
GASCON: LOCAL AND REMOTE MONITORING OF GROUND STATIONS EQUIPMENTS
G. Jalfre, A. Thirouin, and B. Froment (Centre National d'Etudes Spatiales, Toulouse, France) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 163-166 (For primary document see N91-22189 14-17)
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The GASCON (French acronym for automatic management of control stations) system is described. The main features of GASCON is that the off-line system, dedicated to the customization of the monitoring and control applications, is implemented using PROLOG as an artificial intelligence tool. The off-line toolset enables the end user to configure the physical environment through a graphical interface and to describe the monitoring logic by means of a specific high level language. The off-line system can be viewed as a supercompiler which issues the runtime programs which are run by the on-line system. ESA

N91-22217*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
GROUND COMMUNICATION FACILITY (GCF) UPGRADE TASK FOR THE NASA DEEP SPACE NETWORK
J. P. McClure and C. K. Hung *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 167-169 Sponsored by NASA, Washington (For primary document see N91-22189 14-17)
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An overview of the Ground Communication Facility (GCF) upgrade task for the NASA Deep Space Network (DSN) is described. The NASA DSN is a worldwide multimission telecommunications and radiometric facility. The GCF upgrade task is a six year project to be completed by 1993. The task's goal is to develop and implement improved computing, networking, and communication technology, compatible with the standards established by the Consultative Comittee for Space Data Systems (CCSDS). ESA

N91-22218*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
NETWORK MONITORING AND ANALYSIS EXPERT SYSTEM
Young H. Lee *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 171-174 Sponsored by NASA, Washington (For primary document see N91-22189 14-17)
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The Space Flight Operations Center (SFOC) Network Monitoring and Analysis Tool (SNMAT), is a rule-based, prototype expert system designed to assist the operations personnel of the SFOC data system in monitoring the status of the network and in detecting and isolating network and system faults. The main objectives of this tool are: (1) to perform data analysis using advanced user interface techniques; (2) to provide expert advice for resolving network and system faults; and (3) to allow the use of the tool for training operations personnel. As long term benefits, it is anticipated that the tool will promote maximum usage of the network, reduce problem solving time, and assist in operator training. The functionality of the SNMAT program is described, along with some lessons learned through adapting artificial intelligence techniques to an operational environment. ESA

N91-22219# Bell Telephone Mfg. Co., Antwerp (Belgium).
INTERNAL COMMUNICATIONS FOR THE CONTROL CENTRES
Jean-Marie Leroy *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 175-180 (For primary document see N91-22189 14-17)
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The control centers' internal communication requirements are reviewed, outlining the types of messages and further defining the internal communication functions to be performed. A brief local area network (LAN) tradeoff analysis is performed, concluding that most of the communication services can be covered by a modern high speed LAN (HSLN) or broadband metropolitan area network (MAN), such as the emerging fiber distributed data interface (FDDI-2) or the queued packet synchronous switch/distributed queue dual bus (QPSX/DQDB). ESA

N91-22220# National Space Development Agency, Tokyo (Japan).
TYPE 1 SPACE OPERATIONS AND DATA SYSTEM (SODS) CONCEPT
H. Hara, N. Iwasaki, F. Yoshida, S. Kosugi, S. Yamada, K. Moribe, K. Horigushi, Y. Koishi, Y. Kuniyasu, and S. Kuroki (Toshiba Corp., Kawasaki, Japan) et al *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 181-186 (For primary document see N91-22189 14-17)
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With the operation of the H-2 rocket beginning in the early 1990s, it is anticipated that the practical use of space will proceed rapidly and that higher performance and more versatile spacecraft will be developed. In the background of this trend, the Space Operations and Data System (SODS) provides the common basis for a tracking system able to meet the operational requirements of the H-2 and subsequent programs. SODS is divided into three types: (1) for conventional satellites; (2) for the Data Relay and Tracking Satellite System/Japanese Experimental Module; and (3) for advanced spaceflight vehicle. The initial phase of the type 1 SODS is intended for the Japanese Earth Resources Satellite (JERS-1) mission operations. The concept of the type 1 SODS is intended for the JERS-1 mission operations. The Engineering Test Satellite (ETS-4) intersatellite communications experiment, which is part of the experimental system for type 2 SODS, is outlined. ESA

N91-22221*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
SECOND TRACKING AND DATA RELAY SATELLITE SYSTEM (TDRSS) GROUND TERMINAL: STGT
Allen K. Berndt and Dawn R. Lowe *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 187-192 (For primary document see N91-22189 14-17)
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The Second Tracking and Data Relay Satellite System (TDRSS) Ground Terminal (STGT) designed to provide high availability command and control and improved services to users of NASA's space network in the 1990s and beyond is described. The space network, comprising the TDRSS, will be the primary communications gateway for Space Station Freedom and for connecting other user's spacecraft with their ground support elements. The STGT will contain a redundant, distributed computer system providing configuration and control of redundant RF to baseband equipment chains for thoughput of user data, for user tracking services, and for control and monitoring of the TDR satellites. The STGT will provide the following: (1) an interface with NASA's Network Control Center (NCC) for automated scheduling and control of the STGT; (2) a local TDRSS Operations Control Center (TOCC2) for local monitoring and backup control; and (3) an interface with the Domestic Satellite (DOMSAT) for data distribution will be provided by the STGT. ESA

N91-22222*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE EXPLORER PLATFORM PLANNING SYSTEM: AN APPLICATION OF A RESOURCE REASONING PLANNING SHELL
David R. McLean, Brenda J. Page (Bendix Field Engineering Corp., Seabrook, MD.), and William J. Potter *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 195-200 (For primary document see N91-22189 14-17)
(Contracts NAS5-31000; NAS5-27772)
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The Explorer Platform Planning System (EPPS) designed to provide tools which allow mission planners to schedule the platform activities and resource utilization of each mission is described. In order to support scheduling for different missions, EPPS tools are

designed so that the mission specific reconfiguration process can be done with minimum effort and disruption. The planning and scheduling tools which support EPPS are described. ESA

N91-22223*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
GROUND DATA SYSTEM RESOURCE ALLOCATION PLANNING TO SUPPORT MISSION MANAGEMENT
Ralph Durham, Norman B. Reilly, Joe B. Springer, and Thomas M. Taylor *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 201-206 Sponsored by NASA, Washington (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99 CSCL 09F

Mission planning and manangement optimization using unique planning methodologies is described. The ground data system resource allocation process provides mission planners and managers with both short and long range visibility of resource loading. Launch dates, mission designs, and spacecraft sequencing can be planned to optimize science return despite limited resources. Periods of resource contention are identified for managers of flying missions in time for them to plan and implement alternatives rather than be forced to react hastily to unforeseen conflicts. Conflict resolution is by consensus, and a simple route of appeal is provided. ESA

N91-22224# Logica SA/NV, Brussels (Belgium).
MICROGRAVITY EXPERIMENT DESIGN **c18**
Geert Vansteenkiste and Luc Servranckx *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 207-212 (For primary document see N91-22189 14-17)
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The Anthrorack facility for flight on Spacelab (first planned mission Spacelab D2) is described. Anthrorack is designed to support experimentation into human physiology under microgravity. The background and reasons behind the decision to develop a special purpose language, Experiment Description Language (EDL), for the description of Anthrorack experiments are described. The development methodology selected is outlined. It is expected that this approach will offer advantages in terms of more efficient use of crew time, better reliability, greater accessibility, and higher repeatibility of experimental results, which in turn yields a high quality of scientific output from the Anthrorack experiments. The approach offers considerable scope for extension, both within the Anthrorack framework and for similar industrial application fields. ESA

N91-22225# Computer Resources International A/S (Denmark).
PLANERS-1: TOWARDS A NEW GENERATION OF MISSION PLANNING SYSTEMS **c12**
Jens J. Fuchs, Andre Gasquet, and Ken Currie (Edinburgh Univ., Scotland) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 213-220 (For primary document see N91-22189 14-17)
(Contract ESTEC-8122/88/NL/MAC)
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A project within ESA's advanced systems and technology program designed to develop a knowledge-based prototype Earth Resource Observation Satellte (ERS-1), to be launch in 1990-1991 is described. The aim of the prototype system is to provide the user group with a versatile and flexible tool, which can be applied initially as a mission analysis tool and possibly as a mission planning tool. A basic idea of the system is to provide the users with one or more rule like formalisms for expressing the overall planning and scheduling methodology plus the constraint and conflict resolution mechanisms used in the plan construction. A more general aim of the project (and a predecessor project) is to assess the applicability of knowledge based and artificial intelligence methodologies for space related planning problems, and to identify the advantages and drawbacks of such approaches. ESA

N91-22226# Logica Ltd., London (England).
MISSION PLANNING SYSTEMS FOR SCIENTIFIC AND REMOTE SENSING SATELLITES: A COMPARATIVE ANALYSIS **c12**
C. R. Haddow, K. O. Roeska, and Erik Mose Soerensen (European Space Agency. European Space Operations Center, Darmstadt, Germany, F.R.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 221-227 (For primary document see N91-22189 14-17)
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A general definition of the term mission planning is given followed by an overall description of the main parts of a typical mission planning system. A description is given of mission planning systems for the Hipparcos, ERS-1, and Eureca missions. Both commonalities and differences between the mission planning systems of these three missions are identified and discussed. Noting that traditionally mission planning systems were developed as mission specific items for ESA's scientific and remote sensing missions, an attempt is made to separate functions which could form part of a common kernel mission system for multimission support. ESA

N91-22227# Aerospatiale, Cannes (France).
A GROUND BASED EXPERT SYSTEM FOR HERMES ORBITAL OPERATIONS PLANNING
J. Amalric, D. deGabai, F. Paoli, and S. Pouget *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 229-235 In FRENCH; ENGLISH summary Prepared in cooperation with CNES, Toulouse, France (For primary document see N91-22189 14-17)
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The first results of an on going study aimed at proving the feasibility of a knowledge based system devoted to ground center support during the Hermes in orbit phase are presented. The basic functions of this system are mission planning and sequence of events validation, taking into account the actual system configuration and the applicable constraints. The first development step of this system consists in the realization of a mock up devoted to the planning function. Planning work and its modelization, mock up architecture, software tools used, and knowledge representation used are described. Mock up results and future developments are presented. ESA

N91-22228# Academy of Sciences (USSR), Moscow. Inst. of Space Research.
LONG-TERM AND SHORT-TERM PLANNING OF X RAY AND GAMMA OBSERVATIONS ON BOARD THE EARTH SATELLITES **c12**
R. R. Nazirov, E. E. Ryazanova, A. Zukhanov, and N. G. Khavenson *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 237-239 (For primary document see N91-22189 14-17)
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The problem of X-ray and gamma observation planning onboard Earth satellites is considered. Different types of constraints are taken into account. It is possible to include these constraints into the planning process. The planning includes two phases: long term planning with the goal of selecting possible objects among the great number of sources and to compile the preliminary observation program, and short term planning in which the sources to be observed and the observation times are determined. The values of the necessary parameters are evaluated. This planning is used for the operations. ESA

N91-22229# Glavkosmos, Moscow (USSR).
FLIGHT CONTROL DURING INVESTIGATIONS ON BOARD SPECIALIZED SPACE MODULE OF THE 'GAMMA' PROJECT
V. V. Ryumin, V. A. Solovyov, M. Y. Belyaev, D. N. Rulev, and V. P. Teslenko *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 241-246 (For primary document see N91-22189 14-17)
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Problems of planning and control which arise during

investigation in the field of gamma astronomy using a special space vehicle developed for the 'Gamma' project are considered. The program and the scientific and service hardware used for planning and control optimization during research onboard the specialized space vehicle are described. The specialized space vehicle flight control is performed by a ground based complex. During space vehicle flight the following tasks are solved: (1) investigations and service operations planning; (2) command program control; (3) mathematical modeling; and (3) service and scientific telemetry information prompt control. Data analysis for scientific investigations and interpretation is discussed. ESA

N91-22230# Academy of Sciences (USSR), Moscow. Inst. of Space Research.
THE AUTOMATIC RECONSTRUCTION OF 3-DIMENSIONAL SCENES FOR MARS ROVER OPERATIONS c61
M. I. Kolesnik *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 247-251 (For primary document see N91-22189 14-17)
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The algorithm for the stereo pair matching and automatic reconstruction of a three dimensional digital model of terrain is considered. This algorithm, based on the local correlation analysis at the image pyramid, can be employed in landscape mapping and autonomous vehicle vision systems. The reconstructed scene can be used in Mars rover navigation and path planning systems. The total time needed to run the automatic reconstruction program depends on the quality of the original images. The average time needed for the algorithm run via a transputer card is approximately one minute for a 256 by 256 pixel image. ESA

N91-22231# Centre National d'Etudes Spatiales, Toulouse (France).
SPOT IMAGE ORGANIZATION [PLANIFICATION DES PRISES DE VUE SPOT] c12
C. Bastien-Thiry *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 253-257 In FRENCH (For primary document see N91-22189 14-17)
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A program developed to better response to customer needs is described. A series of operational tools for organizing image acquisition by the SPOT satellite are outlined. One of the services offered by the program is that several shots are taken of the area the client is interested in to ensure that the proper meteorological conditions are met. The resource allocation algorithm used in developing the program is described. ESA

N91-22232# Computer Anwendung fuer Management G.m.b.H., Munich (Germany, F.R.).
ROSAT MISSION PLANNING c12
D. Garton and H. Frank (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, Germany, F.R.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 259-262 (For primary document see N91-22189 14-17)
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Rosat (German acronym for X-ray satellite), a scientific spacecraft designed to perform the first all sky survey with a high resolution X-ray telescope and to investigate the emission of specific celestial sources is described. The mission is broadly divided into three phases: calibration, survey, and pointing. The mission planning aspects of the project and of a software system that was developed to perform the different functions required of the Rosat project are described. ESA

N91-22233# Aeritalia S.p.A., Turin (Italy). Space Systems Group.
THE COLUMBUS APM CENTRE FLEXIBLE AND EFFICIENT ENGINEERING SUPPORT
Luciano Battocchio, David R. Harris, and Lorenzo Sarlo *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 263-269 (For primary document see N91-22189 14-17)
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Columbus Attached Pressurized Module (APM) operations, beginning with final testing before loading into the Shuttle, are integrated into the overall Space Station Freedom and Columbus scenarios. These operations, both ground and flight, are supported by an engineering support center, the APMC (APM Center), connected to both Columbus and NASA in orbit infrastructures (IOI). The APMC must fulfill several different roles. The requirements for some roles are reasonably well defined, at least in outline. The requirements for others are still to be defined. Creation of a system for the center which allows all of these roles to be played efficiently and effectively, and when required concurrently is discussed. ESA

N91-22234# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
INFLUENCE ON SPACECRAFT CONTROL SYSTEMS OF EVOLVING O/B TECHNOLOGY AND STANDARDS
Richard Creasey *In its* Ground Data Systems for Spacecraft Control Oct. 1990 p 273-277 (For primary document see N91-22189 14-17)
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Analysis of the operation requirements of future spacecraft show that past approaches are not sufficient. The use of on board (O/B) technology and the development of the specific standards are proposed in order to meet those increasing requirements. The increase in on board decision making capability in spacecraft is discussed. Standardization of spacecraft operations and the impact on present and future ESA standards by this trend are considered. ESA

N91-22235# European Space Agency. European Space Operations Center, Darmstadt (Germany, F.R.).
GROUND SYSTEMS FOR HANDLING PACKET TELEMETRY AND COMMANDS: A CASE STUDY, THE EURECA MISSION
Michael Jones, Erik Mose Soerensen, and Christian Mueller (Logica Ltd., London, England) *In its* Ground Data Systems for Spacecraft Control Oct. 1990 p 279-283 (For primary document see N91-22189 14-17)
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The European Retrievable Carrier (Eureca) mission concept, based upon reusable platform supplying services to a variety of independently operated payloads is discussed. Eureca is characterized by several new on board features, most notably packet telemetry, and a partial implementation of packet telecommanding. As a consequence of the satellite's short contact times with its ground station (3 contacts during the mission in 5 to 8 minute passes), it also has essential built in autonomy features and on board recording of telemetry. The effect of these features on the ground control system are discussed. Special attention is given to: systems requirements, overall design of the ground control system and computer loading and sizing. The processing of packet telemetry is shown to have a significant effect on the computer loading and sizing. The effect of the greater on board autonomy is shown to require quite complex support functions for the operations staff, both for preparing the autonomous operations and then monitoring them a-postiori. ESA

N91-22236*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
FUTURE OPERATIONS FOR SPACE MISSION COMMAND AND CONTROL
Adrian J. Hooke *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 285-289 Sponsored by NASA, Washington (For primary document see N91-22189 14-17)
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A new concept whereby telescience is facilitated by defining allowable 'operations envelopes' within which users are free to operate in a relatively unconstrained mode is presented. Some options for the needed application and communication services are reviewed. The concept of 'telescience' involves giving space mission users an increased degree of autonomy in the conduct of their investigations. In an ideal world, the telescience user would teleoperate a remote instrument or subsystem using completely

transparent data handling services. In reality, the user must work in a constrained environment, usually sharing system resources with others. With current approaches, the command and control path is very slow and unresponsive; this is principally due to the need to protect the overall health and safety of the spacecraft system by extensive planning, scheduling, checking and validation of the user's command activities. ESA

N91-22237# European Space Agency. European Space Operations Center, Darmstadt (Germany, F.R.).
THE EUROPEAN SPACE AGENCY STANDARD FOR SPACE PACKET MANAGEMENT
J. F. Kaufeler *In its* Ground Data Systems for Spacecraft Control Oct. 1990 p 291-295 (For primary document see N91-22189 14-17)
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The ESA concept for the use of the Consultative Commitee for Space Data Systems (CCSDS) defined telemetry and telecommand packets at the application level is presented. These packets are used to remotely monitor and control a spaceborne application. This concept is defined in a packet management standard which should become applicable for all ESA missions using packets. The production of this standard under the responsibility of an ESA standardization group called COES is discussed. ESA

N91-22238# Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (Germany, F.R.).
MARS: A GENERIC MISSION PLANNING TOOL c12
A. Kellner, N. Schielow, and F. Zapp *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 297-303 Prepared in cooperation with Erno Raumfahrttechnik G.m.b.H. (For primary document see N91-22189 14-17)
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A Mission Activities and Resources Scheduler (MARS) is described. It is a mission planning tool for both automatic and interactive generation of spacecraft timelines of realistic complexity, which has been extensively tested during Columbus, Hermes, and Eureca mission planning. It is in operational use for Eureca maneuver planning. It is being extended to full distributed mission planning capability for the Columbus mission planning scenario under the ESA contract New Expert Planning Tool for Users in a Networked Environment (NEPTUNE). The main features of the planning tools used for Columbus, Hermes, and Eureca mission planning are discussed. ESA

N91-22239# Centre National d'Etudes Spatiales, Toulouse (France).
APPLICATION OF CCSDS RECOMMENDATIONS TO ARIANE 5 AND HERMES GROUND SEGMENTS
J. Barbier, D. deStaerke, and J. P. Rocher *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 305-312 (For primary document see N91-22189 14-17)
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New challenges and demands placed on ground data handling, communications and processing which will have to cope with new requirements and constraints of future projects are outlined. To meet these new demands, requirements and constraints, the Consultative Committee for Space Data Systems (CCSDS) has established a set of recommendations for packetized telemetry and telecommand data which provides more efficient, standardized and reliable space ground data communication services. An overview of different configurations which have been considered for the new standardized telemetry and telecommand 'front end' ground functions is presented. The main functional distribution capabilities within the system are reviewed. The application of CCSDS recommendations to Ariane 5 and Hermes handling, control operation requirements and ground to ground data transmission constraints are analyzed and discussed in order to identify the possible applicable functional configurations. ESA

N91-22240# Centre National d'Etudes Spatiales, Toulouse (France).
NAIADE: A PROTOTYPE APPLICATION IN Ada OF THE CCSDS RECOMMENDATIONS CONCERNING 'SFDU' [NAIADE: UNE APPLICATION PILOTE EN ADA DES RECOMMENDATIONS CCSDS 'SFDU']
P. Mazal, D. Minguillon, A. Canals, and P. Vielcanet (CISI Ingenierie, Toulouse, France) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 313-316 In FRENCH (For primary document see N91-22189 14-17)
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The Normalized Automatic Interpreter in Ada for Data Exchange (NAIADE), a prototype data interpreter, is described. It is designed to interpret data transmitted according to the Standard Formatted Data Unit (SFDU) standard established by the Consultative Commitee for Space Data Systems (CCSDS). This standard allows the interpreter to define general data access services independent of the application with which the interpreter is involved. The basic concepts underlying the SFDU standards are outlined. Development of the interpreter for use in two applications is described. One application is the visualization on the ground of satellite orbits. The other application is that of telemetry data decommutation. ESA

N91-22241# Compagnia Italiana Servizi Tecnici, Rome. Space Div.
AN APPLICATION OF TIMED PETRI NETS TO S/C OPERATIONS ANALYSIS: THE ARISTOTELES AUTONOMY CONCEPT
E. Barro and F. Rossi *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 317-322 (For primary document see N91-22189 14-17)
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Petri nets as a methodology for the study and analysis of systems behavior are discussed. They can be tailored to timed approaches, to highlight all the system possible timing critical and deadlock conditions. As a consequence, it is valuable to apply a Petri nets-based methodology in the space environment. Spacecraft operations analysis during system definition is one area of possible application. The application of Petri nets, as a basis for an investigation methodology in the Aristoteles spacecraft autonomy concept definition is described. Significant results are obtained allowing the production of a consistent, formally clean and self explaining system description, to be used as an aid to design and a tool for system evaluation. Such positive achievements support the exploitation of Petri nets-based methodologies in spacecraft operations to describe and analyze the overall space system behavior. ESA

N91-22242# INTECS Toscana S.R.L., Pisa (Italy).
A POSSIBLE ARCHITECTURE OF A DISTRIBUTED HARD REAL-TIME EXECUTIVE FOR SPACE APPLICATIONS c60
S. Sabina and F. Fedi *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 323-329 (For primary document see N91-22189 14-17)
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The modular and scalable architecture of a Distributed Hard Real Time Executive (DHRTE) is described. The DHRTE provides its user with hard real time scheduling algorithms, periodic task and period transformation supports, and synchronous and asynchronous Inter Process Communication (IPC) mechanisms. Implementation details concerning the basic priority inheritance protocol applied to IPC and to the synchronization mechanisms are explored. ESA

N91-22243# Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (Germany, F.R.). Space Systems Group.
SPACECRAFT AUTONOMY CONCEPT VALIDATION BY SIMULATION: A FEASIBILITY ASSESSMENT
U. Pape, A. N. Pidgeon (VEGA Space Systems Engineering Ltd., Harpenden, England), J. Sved, and R. Wilkeit *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 331-336 Previously announced as N91-12741 Prepared in cooperation

with Erno Raumfahrttechnik G.m.b.H. (For primary document see N91-22189 14-17)
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An assessment of the feasibility of simulating the functionality of an autonomous spacecraft and its ground control system by enhancing a simulator and control system is presented. The distributed, hierarchical onboard architecture based on an earlier ESA study (the Standard Generic Approach to Spacecraft Autonomy and Automation (SGASAA)) is described. The architecture utilizes onboard tools for autonomous replanning and enhanced failure diagnosis. The ground control system is changed to enable onboard event reconstruction and the implementation of the autonomous spacecraft simulator is changed to reveal changes in the ground based mission support role. ESA

N91-22244# Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (Germany, F.R.). Space Systems Group.
COLUMBUS GENERIC ELEMENT MANAGEMENT AND PLANNING CONCEPT **c12**
J. Sved and H. Luttmann *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 337-342 Previously announced as N91-12742 Prepared in cooperation with Erno Raumfahrttechnik G.m.b.H. (For primary document see N91-22189 14-17)
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The status of development of the Columbus onboard autonomous control function concept known as the System and Mission Management (SMM) is outlined. The complementary execution timeline planning methodology, that uses Columbus era computer tools is described. The possibility of condensing the documentation tree for payload integration with respect to the operation planning and execution support information is discussed. The use of the Columbus generic element manager command mechanism and data structure to this end is analyzed. ESA

N91-22245# MATRA Espace, Toulouse (France).
KNOWLEDGE-BASED SYSTEMS FOR SPACECRAFT CONTROL: KEYNOTE ADDRESS **c63**
Jean-Michel Darroy *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 345-351 (For primary document see N91-22189 14-17)
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A general overview of Knowledge Based Systems (KBS) applications for spacecraft control is presented. The main benefits demonstrated by, or expected from these applications, expertise capture and preservation, productivity improvements and flexibility are discussed. The major difficulties associated with industrial development of knowledge based systems (knowledge acquisition, expert system validation, lack of specific software engineering methods, performances, and sociological aspects) are identified and discussed. ESA

N91-22246# Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Milan. Space Div.
THE SHELL CONCEPT TO EASE THE DEVELOPMENT OF KNOWLEDGE-BASED SYSTEMS FOR SPACECRAFT CONTROL **c61**
S. Gusmeroli, M. Monti, and A. Pezzinga *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 353-358 (For primary document see N91-22189 14-17)
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The Action Planning Shell (APS) project started to develop an intelligent tool to allow an easy and quick definition of the items needed by an Expert System (ES) for spacecraft operations planning (spacecraft model, flight operations plan, planning methods and contraints) is described. Many different tools, also called shells, exist on the market for developing Knowledge Based Systems (KBS) or ES. These tools are general, in the sense that they can be used for developing ES addressing problems in different domains (planning, troubleshooting, etc.), but offer little guidance on which features to use in a specific application. ESA

N91-22247# Ford Aerospace and Communications Corp., Houston, TX.
MONITORING SHUTTLE ELECTRICAL SYSTEMS USING ARTIFICIAL NEURAL NETWORKS **c63**
George C. Scheuch *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 359-363 (For primary document see N91-22189 14-17)
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A multilayer feed forward artificial neural network with back propagation of error is trained to identify the cause of five different current loads on the Space Shuttle's power distribution system. It is shown that a neural network can correctly identify nominal signatures read from static data files. Even on the slowest personal computers, the networks perform at a rate faster that the real time data rate. A hardware based artificial neural network is predicted to be much faster than a software simulation neural network such as the one used in this study. ESA

N91-22248*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
MULTI-THREADED PROCEDURAL REASONING IN REAL-TIME HEALTH MONITORING OF MANNED SPACECRAFT SYSTEMS
Curtis Ray Welborn and Charles C. Robertson (McDonnell-Douglas Space Systems Co., Houston, TX.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 365-371 (For primary document see N91-22189 14-17)
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Rule based programming is discussed in terms of it being used as a methodology for developing applications. The methodology alone leaves a gap between what is needed for detecting events and what is needed to develop a real time Fault Detection, Isolation and Recover (FDIR) application to monitor and manage a system. In the monitoring and managing of a system, plans need to be carried out within specific time intervals. The completion of or inability to complete a plan is often at the core of an FDIR application. The use of multithreaded procedures in conjunction with rule based programming offers a very powerful mix, which offers both the procedural control and nondeterminism needed for executing a plan and detecting events in a real time application. ESA

N91-22249# MATRA Espace, Toulouse (France).
KNOWLEDGE BASED FRAMEWORK FOR MAN-SYSTEM INTERACTION IN SPACE CONTROL CENTRES **c54**
Francoise Carre, Pascal Richard, Nathalie Carn, and Nathalie Aussenac (Centre National de la Recherche Scientifique, Toulouse, France) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 373-378 (For primary document see N91-22189 14-17)
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An object oriented approach used in developing a model of controlled systems, both in spacecraft and in ground segments is discussed. This model is to be used as a kernel for a variety of applications based on artificial intelligence techniques. Operations within a space control center that can be improved by artificial intelligence techniques are outlined. A model based approach for artificial intelligence presupposes emphasis being placed on the knowledge acquisition step. The integration of artificial intelligence techniques in the operational environment is discussed. ESA

N91-22250# National Space Development Agency, Ibaraki (Japan). Tracking and Control Center.
APPLICATION OF KNOWLEDGE-BASED SYSTEM TO SPACECRAFT MONITORING
Kazuya Kaku, Akira Yamauchi, Kazunori Suzuki, Masumi Nagashima, and Takeo Akashi (Mitsubishi Electric Corp., Kanagawa, Japan) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 379-384 (For primary document see N91-22189 14-17)
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Application of knowledge based systems to spacecraft housekeeping is considered. Two experimental systems developed for the Japanese Communication Satellite-3 (CS-3) are described.

A fault diagnosis system and a monitoring system are developed. It is concluded that the latter is preferable and more easily applied to practical purposes. The monitoring system judges the state of a spacecraft and determines if it is normal. In abnormal cases, it is capable of detecting the cause and can also suggest measures of correcting or amending the problem. It is based on accumulated knowledge of experienced operators, spacecraft designers, and other experts. Problems that have been found in the course of experimentation are presented along with possible solutions so that the monitoring system can further be developed to be effectively utilized in spacecraft monitoring. ESA

N91-22251# MATRA Espace, Toulouse (France).
TOWARDS AN OPERATIONAL FAULT ISOLATION EXPERT SYSTEM FOR FRENCH TELECOMMUNICATION SATELLITE TELECOM 2
M. Haziza *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 385-392 (For primary document see N91-22189 14-17)
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The DIAMS satellite fault isolation expert system shell concept is described. The project, initiated in 1985, has led to the development of a prototype Expert System (ES) dedicated to the Telecom 1 attitude and orbit control system. The prototype ES has been installed in the Telecom 1 satellite control center and evaluated by Telecom 1 operations. The development of a fault isolation ES covering a whole spacecraft (the French telecommunication satellite Telecom 2) is currently being undertaken. Full scale industrial applications raise stringent requirements in terms of knowledge management and software development methodology. The approach used by MATRA ESPACE to face this challenge is outlined. ESA

N91-22252# Aerospatiale, Cannes (France).
SATEXPERT: AN EXPERT SYSTEMS NETWORK FOR AUTOMATIC SPACECRAFT CONTROL
Philippe Gilbertas, Jean-Pierre Courtin, Jean Christophe Chautard, Francois Doladille, Pascal Marrot, Francois Arlabosse, and Nathalie Porte (Framentec, Paris, France) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 393-398 (For primary document see N91-22189 14-17)
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SATEXPERT, a knowledge based system for automatic spacecraft control is described. The software, composed of several cooperating expert systems, will perform, in its operational configuration, a full automatic satellite survey and control including diagnosis and maneuver performance. SATEXPERT is able to detect and diagnose any space segment anomaly and subsequently perform the adequate reconfiguration operation. In a first phase, it will be located at the Satellite Control Center (SCC). Further developments are foreseen to set up the major part of the software onboard the satellite in order to reduce the reaction time and to improve its autonomy. ESA

N91-22253# Computer Resources International A/S (Denmark).
EXPERT OPERATOR'S ASSOCIATE: AN EXPERT SYSTEM FOR SPACECRAFT CONTROL
Mogens Nielsen, Klaus Grue, Bernard Olalainty, Francois Lecouat, and Joe Wheadon (European Space Agency. European Space Operations Center, Darmstadt, Germany, F.R.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 399-407 (For primary document see N91-22189 14-17)
(Contract ESTEC-7627/88/NL/DG)
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The Expert Operator's Associate (EOA) project which studies the applicability of expert systems for day to day space operations is described. A prototype expert system is developed, which operates together with an existing spacecraft control system at the European Space Operations Center and functions as an operator's assistant in controlling satellites. The prototype is demonstrated using an existing real-time simulation model of the MARECS-B2 spacecraft. By developing a prototype system the reliability and effectiveness of operations that can be enhanced by such means are investigated. Questions of acquisition and representation of knowledge for such systems, and the feasibility of migration of some (currently) groundbased functions into future spaceborne autonomous systems are discussed. ESA

N91-22254# VEGA Space Systems Engineering Ltd., Harpenden (England).
AN APPROACH FOR THE APPLICATION OF KNOWLEDGE BASED SYSTEMS TO THE PRODUCTION AND EXECUTION OF SPACECRAFT OPERATIONS PROCEDURES **c61**
Roger S. Thompson *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 409-414 (For primary document see N91-22189 14-17)
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The feasibility of automatically generating spacecraft operations procedures from an object orientated spacecraft model is demonstrated by the Olympus expert system. The Meteosat workstation illustrates how a knowledge based representation of predefined operations procedures can be used for spacecraft control. Ways in which procedure generation and procedure execution systems can be combined into an overall approach, whilst still maintaining a clear distinction between the two stages are presented. This natural break point enables independent validation to be carried out before procedures are used on a live spacecraft and thus satisfies operational safety requirements. ESA

N91-22255*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
KNOWLEDGE SYSTEMS SUPPORT FOR MISSION OPERATIONS AUTOMATION
David J. Atkinson *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 415-418 Sponsored by NASA, Washington (For primary document see N91-22189 14-17)
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A knowledge system which utilizes artificial intelligence technology to automate a subset of real time mission operations functions is described. An overview of spacecraft telecommunications operations at the Jet Propulsion Laboratories (JPL) highlights requirements for automation. The knowledge system, called the Spacecraft Health Automated Reasoning Prototype (SHARP), developed to explore methods for automated health and status analysis is outlined. The advantages of the system were demonstrated during the spacecraft's encounter with the planet Neptune. The design of the fault detection and diagnosis portions of SHARP is discussed. The performance of SHARP during the encounter is discussed along with issues and benefits arising from application of knowledge system to mission operations automation. ESA

N91-22256# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MARVEL: A KNOWLEDGE-BASED PRODUCTIVITY ENHANCEMENT TOOL FOR REAL-TIME MULTI-MISSION AND MULTI-SUBSYSTEM SPACECRAFT OPERATIONS
Ursula M. Schwuttke, John Veregge, R., Robert Angelino, and Cynthia L. Childs *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 419-426 (For primary document see N91-22189 14-17)
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The Monitor/Analyzer of Real-time Voyager Engineering Link (MARVEL) is described. It is the first automation tool to be used in an online mode for telemetry monitoring and analysis in mission operations. MARVEL combines standard automation techniques with embedded knowledge base systems to simultaneously provide real time monitoring of data from subsystems, near real time analysis of anomaly conditions, and both real time and non-real time user interface functions. MARVEL is currently capable of monitoring the Computer Command Subsystem (CCS), Flight Data Subsystem (FDS), and Attitude and Articulation Control Subsystem (AACS) for both Voyager spacecraft, simultaneously, on a single workstation. The goal of MARVEL is to provide cost savings and

productivity enhancement in mission operations and to reduce the need for constant availability of subsystem expertise. ESA

N91-22257# Centre National d'Etudes Spatiales, Toulouse (France).
AN EXPERT SYSTEM FOR GEOSTATIONARY ORBIT SATELLITE BREAKDOWN ANALYSIS [SYSTEME EXPERT DE DIAGNOSTIC DE PANNES DE SATELLITE GEOSTATIONNAIRE]
L. Gibet *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 427-429 In FRENCH (For primary document see N91-22189 14-17)
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Two prototypes of expert systems for breakdown diagnosis on synchronous orbit satellites are described. The first prototype monitors the attitude and orbit control system of the French Telecom 1 satellite. The second prototype monitors the Power Conditioning Subsystem (PCS) of the TDF1 satellite. Both prototypes are intended for use by operation engineers in flight control centers. Both systems use the same expert system programming software generator EMICAT development tool. ESA

N91-22258# Intecs Sistemi S.p.A., Rome (Italy).
ESSOPE: EXPERT SYSTEM FOR SPACECRAFT OPERATIONS PLANNING AND EXECUTION c12
S. Gusmeroli, A. Pezzinga, S. Barone, D. Briatico, and Joe Wheadon (European Space Agency. European Space Operations Center, Darmstadt, Germany, F.R.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 431-436 Prepared for Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Milan (For primary document see N91-22189 14-17)
(Contract ESA-8186/89/D/IM(SC))
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The Expert System for Spacecraft Operations Planning and Execution (ESSOPE) is described. The purpose of the study is to show how the operations planning function can be integrated with the execution function in a ground based real time spacecraft control application and how knowledge based systems are able to provide significant support in both functions. ESSOPE is applied to the Olympus satellite, and will control the high fidelity simulator of the satellite existing at ESOC, through the existing Multi Satellite Support System (MSSS). ESA

N91-22259# European Space Agency. European Space Operations Center, Darmstadt (Germany, F.R.).
USER REQUIREMENTS DETERMINATION AND THEIR IMPLEMENTATION FOR GROUND DATA SYSTEMS FOR SPACECRAFT CONTROL: KEYNOTE ADDRESS
S. J. Dodsworth *In its* Ground Data Systems for Spacecraft Control Oct. 1990 p 439-441 (For primary document see N91-22189 14-17)
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The importance of taking user requirements into consideration in the development of a control system is discussed. The feasibility and operations concept phase of control system development is identified as being a crucial phase. The evolutionary nature of user requirements must be taken into account during the implementation phase. Attention is drawn to the fact that the final product must be validated in the context of the system environment. The managerial challenge of ensuring participation of the right people at each phase of control system development and ensuring that information flow is taking place is discussed. ESA

N91-22260# Computer Technology Associates, Inc., Rockville, MD.
ALTERNATIVE LIFE CYCLE MODELS FOR SPACECRAFT MISSION OPERATIONS SOFTWARE DEVELOPMENT c61
H. J. Bender *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 443-448 (For primary document see N91-22189 14-17)
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The Mission Operations Division (MOD) at the NASA Goddard Space Flight Center is responsible for the development, maintenance, and operation of institutional and dedicated systems to support spacecraft missions. These systems include payload operations control centers, flight software, command management facilities, and spacecraft simulation systems. The MOD uses several software life cycle strategies to fulfill its mission, including the classic waterfall life cycle model, the rapid prototype lifecycle model, and the evolutionary development lifecycle model. Each of these models is described in terms of their practical application in the development and maintenance of spacecraft mission support systems at the MOD. ESA

N91-22261# Marcol Computer Systems Ltd., Darmstadt (Germany, F.R.).
ULYSSES SPACECRAFT CONTROL AND MONITORING SOFTWARE c61
R. W. Corkill *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 449-453 (For primary document see N91-22189 14-17)
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Ulysses is a joint ESA-NASA initiative. The spacecraft, launched in October 1990, will make scientific measurements of the Sun out of the ecliptic plane. The Ulysses SCMS (Spacecraft Control and Monitoring Software) was developed on a ModComp computer in preparation for a May 1986 launch when the Challenger accident occurred. In the four year period caused by the delay, the hardware became obsolete, and it was decided that SCMS be 'converted' to run on DEC/VAX hardware. The conversion project is described concentrating on those aspects which differentiate it from its sister projects. ESA

N91-22262# European Space Agency. European Space Operations Center, Darmstadt (Germany, F.R.).
DETERMINATION OF SPACECRAFT CONTROL SYSTEM USER REQUIREMENTS AND EFFECTS ON DEVELOPMENT METHODOLOGIES
M. Clendining, Nigel C. Head, M. Jones, and A. Wollenberg *In its* Ground Data Systems for Spacecraft Control Oct. 1990 p 455-459 (For primary document see N91-22189 14-17)
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The correct, complete, and timely definition of the user requirements for a spacecraft control system is one of the most difficult tasks in its implementation and certainly provides the largest potential source of costly errors and misunderstandings. The possible reasons for this recurring problem are discussed. Various approaches of ameliorating them are discussed. These approaches may be grouped in three categories: making the best of available (albeit incomplete) information, reducing the implementation impact of incomplete or otherwise incorrect requirements, and improving the availability of accurate spacecraft information to operational users. In each category a number of measures are identified, both technical and managerial. A number of these methods have been used on past and current projects, but their consolidation and incorporation into software engineering standards, other space standards and guidelines is necessary. It is recognized that no single measure will solve the problem and that a combination of approaches will generally be needed. ESA

N91-22263# European Space Agency. European Space Operations Center, Darmstadt (Germany, F.R.).
MANAGEMENT STRATEGIES FOR THE IMPLEMENTATION OF SPACECRAFT CONTROL SYSTEMS
Nigel C. Head *In its* Ground Data Systems for Spacecraft Control Oct. 1990 p 461-466 (For primary document see N91-22189 14-17)
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Constraints involved in the implementation of spacecraft control systems are discussed. The constraints are due both to the end product and to the process used to produce it. The impact of some of these constraints on the management of the implementation team and on the decision making processes required is outlined. The issues selected for discussion are mainly concerned with the process itself rather than the product since

the latter are of a predominantly technical nature. In some cases there appear to be ways to improve the situation. Some tentative proposals in these areas are outlined. In other cases no obvious improvement seems possible. The consequences of the constraints and the potential hazards of trying to change the constraints are discussed. ESA

N91-22264# Compagnia Italiana Servizi Tecnici, Rome. Space Div.

THE REQUIREMENTS ON DATA SYSTEMS OF COLUMBUS LOGISTICS AND ENGINEERING SUPPORT

G. F. DeLuca, S. Masullo, and S. Randisi *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 467-475 (For primary document see N91-22189 14-17)

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The functions served by the Columbus Engineering Support Facilities (ESFs) are outlined. The support these can provide to the operations and control of flight elements during the overall life cycle is discussed. Starting from an analytical review of applicable set of requirements, the activities to be executed in the centers are derived. Subsequently the definition and analysis of the functional requirements of the centers are performed, mainly using the Structured Analysis and Design Technique (SADT) method. A sample operational scenario is taken out from the set of possible system configurations for analysis and discussions using the Petri nets method, in order to highlight the behavior of the ESF and its related transmission modes under contingency conditioning events. The requirements placed on the internal infrastructure concerning data handling aspects, are discussed and assessed providing a possible architecture. Programmatic recommendations are suggested for actual implementation, in compliance with the available and applicable constraints of the Columbus program. ESA

N91-22265*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

WORKSTATION TECHNOLOGY FOR ENGINEERING MISSION OPERATIONS AT THE JET PROPULSION LABORATORY

Kevin J. Miller and Susan C. Murphy *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 477-481 Sponsored by NASA, Washington (For primary document see N91-22189 14-17)

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The Operations Engineering Laboratory (OEL) at the Jet Propulsion Laboratory has been developing graphics tools to automate document preparation in support of space flight mission operations. One such tool, which generates a daily Space Flight Operations Schedule (SFOS), a timeline display of the schedule of spacecraft activities for the Voyager mission is described. The tool consists of two parts: a series of programs that preprocess various command files and a graphics editor. The code of the graphics editor was developed with reusability as a primary objective and has since served as the basis for the generation of other automation tools. ESA

N91-22266# Societe d'Etudes des Systemes d'Automation, Toulouse (France).

OBJECT ORIENTED PROGRAMMING IN MMI: A SOFTWARE TOOL FOR ANALYSIS AND PLANIFICATION OF A RADAR IMAGING MISSION c61

K. VuTien and J. P. Aguttes (Centre National d'Etudes Spatiales, Toulouse, France) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 483-487 (For primary document see N91-22189 14-17)

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The design of a computerized tool for system analysis used mainly in modeling phenomena is discussed. When in a prephase 1 study, since many options are still open and many technical teams are involved, a simulation package can be difficult to use and modify. A computerized tool implemented on a personal computer compatible, in the MS-Windows environment and using object oriented programming is described. This tool offers powerful modeling facilities yet features flexibility and evolution potential, while presenting a friendly user interface for ease of use. It is composed of several cooperative components: a worldwide mission data base, a system builder, a mission builder to create a scenario, and a simulator to evaluate overall mission performances. From several similar object oriented projects conclusions are made concerning the usefulness of such object oriented approaches. ESA

N91-22267*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

OPERATIONS ENGINEERING: TIME FOR A NEW PARADIGM c66

Esker K. Davis and William N. Jensen *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 489-492 Sponsored by NASA, Washington (For primary document see N91-22189 14-17)

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Operations engineering, a new approach to operational effectiveness and efficiency, is described. It is engineering for operations excellence, a bona fide engineering effort focused on the operations phase, but functioning throughout the entire system life cycle. The main objective of operations engineering is productivity: built in productivity, not just the 'make it more productive' type of enhancement that usually occurs after complex systems become operational. Operations engineering designs and integrates people, processes, procedures, hardware, software, and facilities to perform in the most effective and efficient manner, continually improving the technology of operations and enhancing desirable operational attributes. Like systems engineering, operations engineering has its own domain, with characteristics, attributes, functions, and responsibilities. Some of the characteristics of this field of research are summarized. ESA

N91-22268# Vincotte, Brussels (Belgium). Nuclear Safety Analysis Dept.

POSSIBLE USE OF RELIABILITY AND SAFETY ANALYSES FROM OTHER TECHNOLOGIES c38

Pierre Govaerts *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 495-500 (For primary document see N91-22189 14-17)

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Reliability and safety analyses have been developed in the nuclear field since the early sixties. Some of these techniques which might be applied to space domain research are considered. Probabilistic safety analysis, human actions modeling, software reliability, and feedback of operating experience, are some of the domains studied. Improvements in man machine interface developed in better post accident procedures, operator's aids and expert systems are applicable to space research. Fault avoidance in nuclear power plant protection systems software could also be applied to space systems. ESA

N91-22269# Technischer Uerberwachungs-Verein Rheinland e.V., Cologne (Germany, F.R.).

SAFETY IN SOFTWARE FOR MANNED MISSION CONTROL: A CLASSIFICATION METHODOLOGY c61

R. vomHoevel (European Space Agency. European Space Operations Center, Darmstadt, Germany, F.R.), H. Krebs, and M. Clendining *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 501-509 (For primary document see N91-22189 14-17)

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The results of an ESA study into safety and reliability of ground based operations software for manned missions are reported. A summary of existing classification approaches as available in current literature is given (experience outside the space industry is also drawn on). The impact of availability or an 'unsafe state' is discussed. The relevance of multiple channel systems is addressed, coupled with a consideration of process 'monitoring' versus process control. Based on ESA hazard category definitions and a proposed classification of reliability categories, a decision tree for categorizing software into four classes is proposed. An appropriate reliability metric for the four software classes is given in terms of failures

per hour and failures per demand. The problems of measuring the reliability of a piece of software are discussed, and conclusions drawn. ESA

N91-22270# Computer Resources International A/S (Denmark). Space Div.
THE DESIGN OF ERROR TOLERANT INTERFACES c54
Erik Hollnagel *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 511-514 (For primary document see N91-22189 14-17)
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The principles involved in the design of Error Tolerant Interfaces (ETI) are outlined. An ETI is characterized as being robust against the disturbances and inaccuracies of man machine interaction that may result from temporary capacity reduction of the operator and from impediments of human reliability in general. An ETI is able to absorb and compensate for degraded input and to provide output in a form of presentation which can be interpretated correctly even under suboptimum working conditions. This is significant in the case of work under stressed conditions or high time pressures, on the ground or in orbit, as a countermeasure to the adverse effects of reduced human reliability. ESA

N91-22271# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
ESTABLISHING A SOFTWARE PRODUCT ASSURANCE DATABANK FOR SOFTWARE RELIABILITY DESIGN, DEVELOPMENT, AND ASSESSMENT c61
R. Borcz and R. Glasl *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 515-520 (For primary document see N91-22189 14-17)
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A means of ensuring major improvement in software reliability is outlined. A software product assurance databank is suggested as a means of controlling software reliability. The steps involved in establishing such a databank, the data to be collected, the means of collection, and other development and application details are outlined. Such a databank, designed for the purpose of analyzing and improving the process of software development is predicted to minimize the introduction of faults and maximize fault finding capabilities. ESA

N91-22272# Societe d'Etudes des Systemes d'Automation, Toulouse (France).
FIABAI: A KNOWLEDGE BASED SYSTEM FOR THE EVALUATION OF THE RELIABILITY-AVAILABILITY OF COMPLEX COMPUTER ARCHITECTURES c60
G. Jalfre, C. Levy, and F. Chabanne (Centre National d'Etudes Spatiales, Toulouse, France) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 521-525 In FRENCH (For primary document see N91-22189 14-17)
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The FIABAI software intended for use in modeling and analysis applications in mission control centers and in spaceborne computers is described. The aim of FAIBAI is to give the creator of computer architectures the ability to evaluate redundancies between different architectural variations in order to improve security. The software tool presented allows reliability parameters to be described using the language with which the programmer feels most comfortable. A graphic interface is used to facilitate contact between man and computer. The FIABAI software can automatically produce reliability block diagrams of Markov graphs corresponding to the different system's missions. ESA

N91-22273*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
DISTRIBUTED VOICE CONTROL FOR THE LARGE SCREEN DISPLAY IN THE MISSION CONTROL CENTER
Curtis Ray Welborn (Ford Aerospace and Communications Corp., Houston, TX.) and George C. Scheuch *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 529-532 (For primary document see N91-22189 14-17)
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A voice controlled prototype of a worksation based system called Projection Plotting Display (PPD) was developed to demonstrate voice recognition technology and to assess its feasibility for PPD. Additional hardware for the prototype included a Votan VTR 6050 voice terminal and a DECtalk DCT01 voice synthesizer. Additional software include a command parser as well as several modules to control both Votan and DECtalk. Changes to the original software are minimal. Operation of the voice system are simple and do not prevent use of the keyboard. Votan compares spoken words to a previously trained vocabulary. Recognized words are tokenized and sent to the display as a command string. At the workstation, the command parser converts the Votan command tokens into text strings. These strings are exactly like those that otherwise would have been typed at the PPD keyboard, and they are executed by the original PPD command handler. Responses to the oral commands, error messages, and advisories are spoken by DECtalk. ESA

N91-22274*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
GENERIC MESSAGE MANAGEMENT
Curtis Ray Welborn *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 533-538 (For primary document see N91-22189 14-17)
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Monitoring the health and status of any dynamic system by a user always presented the problem of information overload if multiple events occur. This overload is often in the form of too many advisory messages sent to a display. To reduce information overload, only those messages which abstract the occurrence of an event may be printed. This solution has a problem in that there is no explanation given for why a high level message was generated. Generic Message Management (GMM), which is being developed to assist with information overload, message explanation, and historical logging for trend analysis, is discussed. ESA

N91-22275# Science Systems Ltd., Bristol (England).
THE USE OF TWIN-SCREEN-BASED WIMPS IN SPACECRAFT CONTROL
R. D. Klim *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 539-543 (For primary document see N91-22189 14-17)
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The ergonomic problems of designing a sophisticated Windows Icons Mouse Pop-up (WIMP) based twin screen workstation are outlined. These same problems will be encountered by future spacecraft controllers. The design of a modern, advanced workstation for use on a distributed multicontrol center in a multisatellite control system is outlined. The system uses access control mechanisms to ensure that only authorized personnel can undertake certain operations on the workstation. Rules governing the use of windowing features, screen attributes, icons, keyboard and mouse in spacecraft control are discussed. ESA

N91-22276# Logica Ltd., London (England).
WORKSTATION TECHNOLOGY AND MMI TECHNIQUES FOR THE EUTELSAT 2 TELEMETRY, COMMAND AND RANGING SYSTEM
H. Smith *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 545-551 (For primary document see N91-22189 14-17)
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Spacecraft control facilities for the operational phase of the Eutelsat 2 series of communications satellites are described. The facilities provide highly reliable telemetry, command and ranging services through a control center in Paris and two ground stations at Sintra, Portugal and Rambouillet, France. The current system is designed to support up to six satellites in geostationary orbit. Remote monitoring and control of the ground stations from the Paris center is provided. Extensive redundancy is provided throughout, and a remote backup satellite control capability is installed at Rambouillet. The design techniques used to implement

the operator (user) interface to the Eutelsat facilities are described. Possible future developments of these concepts are identified and the provision of a Generalized Monitor and Control Interface (GMCI) is proposed. The technologies required and the benefits that can be achieved, are identified. ESA

N91-22277*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
INFORMATION VISUALIZATION TECHNIQUES IN A MULTI-MISSION OPERATIONS ENVIRONMENT
Edmund C. Baroth, Gregory E. Chin, and Patrick S. Curran *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 553-558 Sponsored by NASA, Washington (For primary document see N91-22189 14-17)
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In the near future, the number of major missions flying simultaneously will increase. This increase in data will place a heavier burden on the operations staff to verify the health and status of a spacecraft or intrument platform. The problem of verification becomes particularly acute when multiple flight projects are being supported by the same personnel. Operations must be made more efficient and automated to remain successful. A prototype concept for achieving that goal is described. The prototype shows how the concepts of information visualization and information retrieval can be applied in developing a user oriented interface for a multimission operations environment. The proposed user interface integrates existing prototypes and includes two dimensional and three dimensional color graphics, animation, and simulation. Techniques of data realization are included. ESA

N91-22278# MATRA Espace, Toulouse (France).
HYPERMEDIA TOOL FOR OPERATIONAL PROCEDURE: CREATION AND UTILIZATION **c61**
J.-Y. Marson and P. Gremillon *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 559-562 (For primary document see N91-22189 14-17)
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A tool dedicated to assisting operational staff in creating, updating and using procedures is described. The tool is to be used in the Telecom 2 Spacecraft Control (S/C) center project. Procedures are to be created and modified several times before and during the S/C life. Difficulties in carrying out such modifications are outlined. The tool proposes a set of solutions to these problems using a new methodological approach and hypermedia technology. It is implemented on an Apple computer. The man machine interface is developed with SuperCard software. Documentation is implemented and assessed with the RDBMS Oracle. ESA

N91-22279*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
TRANSPORTABLE APPLICATIONS ENVIRONMENT (TAE) PLUS: A USER INTERFACE DEVELOPMENT AND MANAGEMENT SYSTEM
Martha R. Szczur *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 563-569 (For primary document see N91-22189 14-17)
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The Transportable Applications Environment Plus (TAE Plus) a portable What You See Is What You Get (WYSIWYG) user interface development and management system is described. Its primary objective is to provide an integrated software environment that allows interactive prototyping and development of user interfaces, as well as management of the user interface within the operational domain. Although TAE Plus is applicable to many types of applications, its focus is supporting user interfaces for realtime space applications. What TAE Plus provides and how the implementation has utilized state of the art technologies within graphic workstations, windowing systems and object oriented programming languages are outlined. ESA

N91-22280*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MULTI-MISSSION SPACECRAFT PLANNING AND CONTROL PROCESS: MULTI-MISSION SEQUENCE OF EVENTS
Joseph C. Hu and Gregory E. Chin *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 571-575 Sponsored by NASA, Washington (For primary document see N91-22189 14-17)
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The multi-mission sequence of events generation susbsystem, developed to provide an integrated, user friendly environment for spacecraft mission planning and control, is described. The software translator modules, an advanced distributed object oriented data manager, a knowledge based expert system, and output generator programs are described. The subsystem generates integrated sequence of events files for general spacecraft and ground activity planning, monitoring, and control. It generates keyword files to operate and configure the deep space network stations. It also generates space flight operations schedule graphs for easy visualization and planning. The data generated are fed into graphical editors developed on Sun workstations for easy point and click editing, producing true What You See Is What You Get (WYSIWYG) hardcopy output. ESA

N91-22281# VEGA Space Systems Engineering Ltd., Saint-Albans (England).
MAN-MACHINE INTERFACE (MMI) ASPECTS OF WORKSTATIONS FOR USE IN SPACECRAFT OPERATIONS **c54**
Roger S. Thompson *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 577-582 (For primary document see N91-22189 14-17)
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Modern engineering workstation computers, with multiple high resolution color monitors, employing multiwindow software to manage the organization of the display, provide an ideal platform for the implementation of spacecraft monitoring and control systems. The prototype Meteosat advanced operations workstation which demonstrates many of the man-machine interface features which such a system can provide, including interactive graphical status displays, is described. The user interface draws together the requirements of the online tasks performed by spacecraft operators and the offline analysis functions performed by spacecraft engineers, enabling a single system to support both classes of user. ESA

N91-22282*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
DEVELOPING A USER-INTERFACE-EVALUATION TOOL FOR SPACE-STATION-ERA APPLICATIONS **c54**
Shari A. Bahder, Elizabeth D. Murphy (Computer Technology Associates, Inc., Rockville, MD.), Sylvia B. Sheppard, and Walter Truszkowski *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 583-587 (For primary document see N91-22189 14-17)
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The development of progressively more intelligent interface dsign aids is described. The first generation of the Computer Human Interaction Models (CHIMES) methodology and toolset identifies trouble spots in an existing or proposed design. The second generation, CHIMES-2, provides the designer with intelligent assistance in formulating modifications to correct identified problems. The approaches used in development of the CHIMES-2 capabilities and knowledge bases are outlined. Implementation of the phase 1 prototype is described. Future directions include integration with other design tools, implementation of a design library, and further theoretical work. The final objective of the research and development effort is a total workstation environment for the designer of computer human interfaces for spacecraft control. ESA

N91-22283# INTECS Toscana S.R.L., Pisa (Italy).
THE SCOS MAN-MACHINE INTERFACE PROJECT **c54**
Paolo Coppola and Bruno Mullet (European Space Agency. European Space Operations Center, Darmstadt, Germany, F.R.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 589-595 (For primary document see N91-22189 14-17)
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The software infrastructure developed for the management of the man-machine interface of the Spacecraft Control and Operation System (SCOS) over a network of workstations is described. The software provides multimission facilities for the configuration management of the desktops of user categories, for privileges and activities monitoring and control, for data presentation and user input interpretation and for handling distributed applications. The facilities ease the implementation integration and operation activities of the man-machine interface designers and application programmers of the spacecraft control systems and guarantee a standard 'look and feel' for end users. ESA

N91-22284# Marcol Computer Systems Ltd., Darmstadt (Germany, F.R.).
MSCC CONSOLE DEMONSTRATOR PROJECT **c54**
P. Hall and M. Drexler (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, Germany, F.R.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 597-600 (For primary document see N91-22189 14-17)
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The Columbus ground data systems will employ a number of new technologies including advanced graphical user interfaces, networked workstations and Ada. Each of these new technologies present new challenges to engineers and managers. In order to reduce the technical risk and to control life cycle costs, a pilot project is proposed to develop a control room demonstration console. The Manned Space Laboratories Control Center (MSCC) console demonstrator is a prototype of the console to be used in the MSCC ground data system during Columbus. It has two-operator positions with access to the existing MSCC voice, video and timing facilities. The console workstations are networked to a simulator which will generate telemetry data for display at the Console demonstrator Man Machine Interface (MMI). Development of the MSCC console demonstrator provides important information about the MMI and networking design. It also serves as a testbed for new technologies. ESA

N91-22285# SAT Control, Labege (France).
COMPUTER DIALOGUE TECHNIQUES FOR SATELLITE OPERATIONS **c61**
L. Buys, C. Durand, and G. Mace *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 601-606 (For primary document see N91-22189 14-17)
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An overview of how modern computer dialogue techniques can be used for operations in the satellite control centers is presented. Major progress brought by these techniques for data display, function activation and data inputs is highlighted. These techniques enable the combination in one display of different types of representation such as performance, semi-graphic elements and plots. They ease the function activation and the data selection by a combination of symbols and menus displayed on screen, which are designated by the operator using the mouse device. Another main aspect of the ergonomics is centralized access to the system via a permanent system banner that presents essential information such as the satellite alarm status and provides direct access to all major system functions. Response times with respect to different operation types and access control are shown as contributing to system ergonomics and security. The dynamic aspect of man-machine dialogue is demonstrated by means of an operations scenario. General recommendations are drawn with respect to the standardization requested for menus, color use and operators' degree of freedom, while respecting operations security. ESA

N91-22286# Computer Anwendung fuer Management G.m.b.H., Munich (Germany, F.R.). Technical/Scientific Div.
THE USE OF DATABASES IN GROUND DATA SYSTEMS FOR SPACECRAFT CONTROL
John Dallat *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 609-613 (For primary document see N91-22189 14-17)
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The various purposes for which databases can be used are discussed with a closer look at the evolution of databases for spacecraft telemetry processing systems. Efficiency and feasibility aspects are considered. Current trends in the generation of spacecraft telemetry databases are reviewed, and future trends in database technology are discussed. The use of expert systems in fault diagnosis, operator assistance in responding to spacecraft anomalies and other such applications is discussed ESA

N91-22287# Societe d'Etudes des Systemes d'Automation, Frankfurt (Germany, F.R.).
CONFIGURABLE SPACECRAFT CONTROL SYSTEMS **c61**
X. A. Debest and Bruno Mullet (European Space Agency. European Space Operations Center, Darmstadt, Germany, F.R.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 615-619 (For primary document see N91-22189 14-17)
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Techniques used to produce configurable systems which can be reused for various and different missions are discussed. There are major challenges with this technique, which can be resolved through the utilization of a general purpose configuration database management tool. This tool permits the easy definition of configuration tables and automatic generation of their description. It is also able to generate configuration parameter values from the contents of the application database. The number of configuration parameters to be maintained can thus be reduced drastically, and their overall consistency can be checked before they are used. The configuration parameters defined in ORACLE databases and generators are used to produce the derived configuration tables and their descriptions in the form required by the application programs. A first implementation of this tool is targeted for use on Ada programs. Generators for other languages will be developed as required. ESA

N91-22288# Science Systems Ltd., Bristol (England).
A DISTRIBUTED DATABASE DESIGN FOR MULTI-CONTROL CENTRE SYSTEMS
J. B. Haynes *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 621-625 (For primary document see N91-22189 14-17)
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A generic data model of a distributed system is discussed. Some of the basic considerations which need to be applied to a single control center environment before widening the discussion to include multicontrol center systems are presented. Reference is made to typical operational scenarios relating to multicontrol center systems. The problems to be faced and overcome by the designer are outlined. Distributed databases are complex to design and manage, and their use requires careful justification. Resilience and survivability are common justifications for high availability control systems; such conditions are synonomous with multicontrol center systems. ESA

N91-22289# Societe d'Etudes des Systemes d'Automation, Puteaux (France).
GEOGRAPHIC DATA BASES FOR MISSION CONTROL CENTERS [BASE DE DONNEES GEOGRAPHIQUES POUR CENTRES DE CONTROLE ET DE MISSION]
R. dePeufeilhoux *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 627-629 In FRENCH (For primary document see N91-22189 14-17)
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The various numeric geographical data bases available are described. Problems involved in using these databases in mission control centers are outlined. Data management, data quality and

other practical aspects of the geographical databases in remote sensing applications are dicussed. Topographic, altimetric and thematic data are evaluated. A geographical database designed to offer complete planet wide coverage on a scale of one to a million is described. ESA

N91-22290# European Space Agency. European Space Operations Center, Darmstadt (Germany, F.R.).
THE ESOC SPACECRAFT PERFORMANCE EVALUATION SYSTEM (SPES) **c18**
F. Sell and J. F. Kaufeler *In its* Ground Data Systems for Spacecraft Control Oct. 1990 p 631-634 (For primary document see N91-22189 14-17)
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The Spacecraft Performance Evaluation System (SPES) developed to cope with the increasing complexity of equipment carried by spacecraft is described. The SPES stores spacecraft related life time data in a central repository and provides user friendly and flexible retrieval access. Retrieved data can be presented in a variety of ways on user workstations. SPES is implemented as a system of cooperating jobs on the central ESOC offline computer and on personal computer workstations. As it is functionally decoupled from the mission control systems, ESA external users can use it without inherent risks. The SPES is currently used for the Hipparcos and will be used for ERS-1, Eureca and other missions. ESA

N91-22291*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
KEYNOTE ADDRESS: THE IMPLICATIONS OF TELESCIENCE
Adrian J. Hooke *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 637-639 Sponsored by NASA, Washington (For primary document see N91-22189 14-17)
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The history of the development of telescience is outlined. One of the fundamental concepts of telescience is identified as the exploitation of Open Systems Interconnection (OSI). A more modern definition of telescience which views it more as an environment than as an activity is described. Within this model, a telescience user exploits geographically distributed computing and communications capabilities to perform four discrete activities. These activities, teledesign, teleplanning, teleoperation and teleanalysis, are rooted in three common concepts. These concepts are outlined. ESA

N91-22292*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
TELESCIENCE TESTBEDDING: TECHNICAL AND OPERATIONAL REQUIREMENTS FOR AN INTERNATIONAL CAPABILITY
Arshad Mian and Daryl Rasmussen *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 641-645 (For primary document see N91-22189 14-17)
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Clear and predetermined definitions of interoperability, data exchange, standards and commonality are identified as crucial in research and development work involving the participation of several countries. Such international cooperation includes payloads of several countries flown together on a platform developed by a different country. This environment necessitates that privacy and security also be ensured. Testbedding as a means of rapid prototyping new technologies and operational scenarios is outlined. Several NASA, European and Japanese programs employing this methodology to evaluate and develop telescience capabilities for space science users and mission operators are described. Collaborative testbeding by international participants can provide the focus for studying some of the key interface and operational issues for the space and ground information and communication systems of the 1990's. Existing NASA, ESA and NASDA testbeds, an architecture for interconnecting them, potential for joint utilization, and some management concepts for fostering collaboration are described. ESA

N91-22293# VEGA Space Systems Engineering Ltd., Harpenden (England).
TELESCIENCE: A SCIENTIST'S DREAM OR AN OPERATIONAL NIGHTMARE
J. Clear and M. Clendining (European Space Agency. European Space Operations Center, Darmstadt, Germany, F.R.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 647-652 (For primary document see N91-22189 14-17)
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The results of an ESA study into the applicability and possible usage of telescience are reported. Its purpose is to analyze the impact of telescience on all aspects of spacecraft operations. An analysis of the requirements of both the users and the operators is presented. A classification of previous and planned missions is given, followed by an analysis of the applicability of the telescience operations to each mission class. A number of major problems are identified, including programmatic, operational, and technical difficulties. It is shown that most of these problems can be solved, but with increased costs to the users and potentially to the mission control. Future developments in telescience operations and the necessary activities to be completed before the telescience 'dream' becomes a reality are discussed. ESA

N91-22294*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
TRANSPORTABLE PAYLOAD OPERATIONS CONTROL CENTER
John Koslosky, Ronald Mahmot, Daniel Mandl, and William Stratton (Integral Systems, Inc., Lanham, MD.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 653-658 (For primary document see N91-22189 14-17)
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The Transportable Payload Operations Control Center (TPOCC), an architecture for control centers which makes use of new mission operations and reduces development costs, is described. The TPOCC architecture takes an open networking approach based on widely accepted industry standards. Small inexpensive computers are networked together, performing the functions of a mini or mainframe computer. This approach, along with TPOCC's reusable components, provides versatile ground support systems for Mission Operations Division's (MOD) customers. ESA

N91-22295# Telespazio, S.p.A., Rome (Italy).
THE DESIGN OF THE SAX SCIENTIFIC DATA ARCHIVE FOR A QUICK LOOK AT THE ROTATIONAL CONTROL CENTRE
F. DAlessandro, A. Coletta, B. Negri, and M. Trifoglio (Consiglio Nazionale delle Ricerche, Bologna, Italy) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 659-663 (For primary document see N91-22189 14-17)
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The Reformatted Raw Data (RRD) archive design of the SAX X-ray astronomy satellite is described. Its capabilities of fast, flexible storing and retrieving, and interpreting the nature of data, and the capability of copying the online RRD onto optical disk storage are described. The peculiarity of the SAX RRD arises from nonuniformity among data coming from several experiments. The RRD structure is organized such that it is capable of storing and retrieving high traffic data volume in almost real time. Five types of instruments are present on the SAX satellite and each one performs separate experiments in various operative modes and submodes. The transmitted scientific data have to be processed in quick look mode; thus, a high level performance design at the Operational Control Center (OCC) is required. ESA

N91-22296# Bell Telephone Mfg. Co., Antwerp (Belgium).
GROUND COMMUNICATIONS FOR THE IN-ORBIT INFRASTRUCTURE
Ray Hind and P. Dosiere *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 665-670 (For primary document see N91-22189 14-17)
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Communication requirements, including those of the scientific user within ESA's in orbit infrastructure are reviewed. It is concluded

that merging broadband and metropolitan area networks standards provide a solution for both local and wide area communications requirements. Multimedia and delay aspects of telescience are reviewed. Network management and transmission issues are discussed. Fault tolerant topologies and ground communication solutions are considered. ESA

N91-22297# Compagnia Italiana Servizi Tecnici, Rome.
TELESCIENCE EXPERIMENT INTEGRATION AND EVALUATION EXERCISE
A. Guerrazzi *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 671-676 (For primary document see N91-22189 14-17)
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Definition of a generic approach for the integration and evaluation of teleoperated experiments in Columbus-like scenarios, is discussed. Basic points and procedures that have proved very useful in the integration and evaluation of two new pilot experiments are described. The Plateau Tank Facility (PTF) and TELEPODI are chosen as representative of user experiments. The PTF is meant to observe the mechanical behavior of liquid bridges in microgravity conditions, while TELEPODI is a teleoperated version of the PODI diagnostic tool capable of interferometry and Schlieren observation of a guest experiment volume. The roles of the telescience testbed, the user work station and onboard hardware interfaces are reviewed. ESA

N91-22298# National Aeronautical Lab., Tokyo (Japan).
TELESCIENCE TESTBED RESULT FOR JAPANESE EXPERIMENT MODULE
K. Matsumoto, K. Higuchi, H. Kimura, N. Takeda, S. Matsubara, M. Izumita, Y. Toyama, M. Kato, and H. Kato (Nippon Electric Co. Ltd., Tokyo, Japan) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 677-681 (For primary document see N91-22189 14-17)
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The first telescience testbed experiments for the Japanese Experiment Module (JEM) of the Space Station Freedom, conducted after the three year studies of its system requirements, are described. Three experiment themes of the First Material Processing Test (FMPT) of the Japanese Spacelab Mission are chosen for estimating communications requirements between the JEM and a ground station. A paper folding experiment is used to examine instruction aspects of onboard manual processing and onboard coaching. More than 10 principal investigators partipated in the experiments and were requested to answer a rating questionnaire for data acquisition. The results extracted from the questionnaire are summarized. ESA

N91-22299# Computer Anwendung fuer Management G.m.b.H., Munich (Germany, F.R.). Technical/Scientific Div.
HIGH RATE TELEMETRY FOR THE SPACELAB D-2 MISSION
Hanno Stubbusch *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 683-687 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

A high rate telemetry handling and data processing system for the German Space Operations Center (GSOC) is described. The system is based on experience gained in previous manned missions such as the First Spacelab Project (FSLP) and Spacelab D-1 CAM. The various requirements for telemetry services to be provided by GSOC as the Payload Operations Control Center (POCC) for the D-2 mission led to a layered implementation of the telemetry system with multiple access points and data gateway functions. The transfer frame format defined by the Consultative Committee on Space Data Systems (CCSDS) is implemented for the data exchange between NASA and GSOC. The hardware and software architecture of the GSOC D-2 system for the POCC functions is shown to demonstrate the handling of high telemetry for a manned mission with Columbus-like requirements. ESA

N91-22300# Academy of Sciences (USSR), Moscow. Inst. of Applied Mathematics.
SYSTEM FOR INFORMATION PROCESSING AND EXECUTING CALCULATIONAL TASKS FOR BALLISTIC AND NAVIGATION SUPPORT OF SPACECRAFT MISSION
E. L. Akim and A. G. Tuchin *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 691-697 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

The role of ballistic centers in ground based control and management systems is outlined. They process the trajectory measurements transmitted by the tracking stations. They determine the trajectory parameters to calculate the parameters of maneuvers. The development of software systems for ballistic and navigation support of spacecraft missions is described. It is done in such a way that the information and management means are separate components. The information and management system consists of the Information and Control Computer (ICC) and computers for calculations. The architecture of the computer system is described. ESA

N91-22301# Joanneum Research Centre, Graz (Austria). Inst. for Information Management.
MAKING TELESCIENCE POSSIBLE: AN ANALYSIS OF THE USE OF STANDARD TECHNIQUES TO REDUCE USER EFFORTS
Walter Koch (Technische Univ., Graz, Austria) and Thomas Zeyringer *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 701-704 (For primary document see N91-22189 14-17)
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Developments in data handling techniques in telemetry are discussed. User requirements considerations and ways in which existing standards can be used are given special attention. Standards are taken into account when they relate to systems engineering and data formatting techniques. The time taken to store and access data is discussed. Data completeness and quality is reviewed. The development effort required by the end user is discussed. Usage of existing standards in ways that save implementation costs for individual telescience users is studied. ESA

18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls.

For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics,* and *16 Space Transportation.*

N91-22302*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RIGID-BODY-CONTROL SUBSYSTEM SIZING FOR AN EARTH SCIENCE GEOSTATIONARY PLATFORM
A. Don Scott, James A. Duricy, and Cheryl C. Jackson (Flight Mechanics and Control, Inc., Hampton, VA.) Washington May 1991 22 p
(NASA-TP-3087; L-16796; NAS 1.60:3087) Avail: NTIS HC/MF A03 CSCL 22B

The Mission to Planet Earth Program envisions both low-Earth and geostationary orbiting spacecraft supporting instruments that will measure and monitor land, ocean, and atmospheric variables that are important to understanding Earth's global change mechanisms. In order to minimize the number of spacecraft required in geostationary orbit, large multi-purpose platforms were proposed which will carry many high resolution science instruments and sensors. Several of these instruments are large antennas which tend to accentuate the environmental and spacecraft-induced disturbances, thereby affecting spacecraft controllability. A

rigid-body pointing analysis was conducted to determine if the subject spacecraft could maintain pointing to within a very precise 18-arcsec measured at the rigid payload module. Two reaction wheel assemblies, the NASA standard and the Space Telescope, were investigated as attitude control devices. The results indicate that the spacecraft can theoretically be controlled to maintain the 18-arcsec requirement along each axis. Of the two reaction wheel assemblies, the Space Telescope assembly provided the highest degree of pointing accuracy along with a slight increase in mass and power requirements. The reaction wheels investigated are all representatives of what is currently available. A computer-aided engineering system called space systems integrated simulation (SPASIS) was used to support this analysis. Author

N91-22303*# Thiokol Corp., Brigham City, UT. Space Operations.
RSRM TOP HAT COVER SIMULATOR LIGHTNING TEST, VOLUME 1 Final Report
Jul. 1990 31 p
(Contract NAS8-30490)
(NASA-CR-184109; NAS 1.26:184109; TWR-60834-Vol-1; Publ-91231-Vol-1) Avail: NTIS HC/MF A03 CSCL 22B

The test sequence was to measure electric and magnetic fields induced inside a redesigned solid rocket motor case when a simulated lightning discharge strikes an exposed top hat cover simulator. The test sequence was conducted between 21 June and 17 July 1990. Thirty-six high rate-of-rise Marx generator discharges and eight high current bank discharges were injected onto three different test article configurations. Attach points included three locations on the top hat cover simulator and two locations on the mounting bolts. Top hat cover simulator and mounting bolt damage and grain cover damage was observed. Overall electric field levels were well below 30 kilowatts/meter. Electric field levels ranged from 184.7 to 345.9 volts/meter and magnetic field levels were calculated from 6.921 to 39.73 amperes/meter. It is recommended that the redesigned solid rocket motor top hat cover be used in Configuration 1 or Configuration 2 as an interim lightning protection device until a lightweight cover can be designed. Author

N91-22304*# Thiokol Corp., Brigham City, UT. Space Operations.
RSRM TOP HAT COVER SIMULATOR LIGHTNING TEST, VOLUME 2. APPENDIX A: RESISTANCE MEASUREMENTS. APPENDIX B: LIGHTNING TEST DATA PLOTS Final Report
Jul. 1990 137 p
(Contract NAS8-30490)
(NASA-CR-184111; NAS 1.26:184111; TWR-60834-Vol-2-App-A/B; Publ-91231-Vol-2-App-A/B) Avail: NTIS HC/MF A07 CSCL 22B

Resistance measurements are given in graphical for when a simulated lightning discharge strikes on an exposed top hat cover simulator. The test sequence was to measure the electric and magnetic fields induced inside a redesigned solid rocket motor case. Author

N91-22305*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NASA FUTURE MISSION NEEDS AND BENEFITS OF CONTROLS-STRUCTURES INTERACTION TECHNOLOGY
William L. Grantham Jan. 1991 24 p
(NASA-TM-104034; NAS 1.15:104034) Avail: NTIS HC/MF A03 CSCL 22B

Two questions are addressed: (1) which future missions need Controls-Structures Interaction (CSI) technology for implementing large spacecraft in orbit; and (2) what specific benefits are to be derived if the technology is available? The answers to these questions were used to help formulate and direct the CSI technology development program. Many future NASA missions have common CSI technology needs which can best be developed in a broad-based, but focused, technology program to provide the greatest benefit to the largest number of users. Three CSI benefit studies were completed to date as part of ongoing assessment process: (1) missions requiring large antennas; (2) missions requiring large optical systems; and (3) missions requiring the use of closed-loop controlled, flexible, remote manipulator systems (RMS) for in-space assembly. The large antenna and flexible RMS mission benefits are discussed. Author

N91-22306*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CONCEPTUAL DESIGN OF A MULTIPLE CABLE CRANE FOR PLANETARY SURFACE OPERATIONS
Martin M. Mikulas, Jr. and Li-Farn Yang (Colorado Univ., Boulder.) Jan. 1991 23 p
(NASA-TM-104041; NAS 1.15:104041) Avail: NTIS HC/MF A03 CSCL 22B

A preliminary design study is presented of a mobile crane suitable for conducting remote, automated construction operations on planetary surfaces. A cursory study was made of earth based mobile cranes and the needs for major improvements were identified. Current earth based cranes have a single cable supporting the payload, and precision positioning is accomplished by the use of construction workers controlling the payload by the use of tethers. For remote, autonomous operations on planetary surfaces it will be necessary to perform the precision operations without the use of humans. To accomplish this the payload must be stabilized relative to the crane. One approach for accomplishing this is to suspend the payload on multiple cable. A 3-cable suspension system crane concept is discussed. An analysis of the natural frequency of the system is presented which verifies the legitimacy of the concept. Author

N91-22307*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FOURTH NASA WORKSHOP ON COMPUTATIONAL CONTROL OF FLEXIBLE AEROSPACE SYSTEMS, PART 1
Lawrence W. Taylor, Jr., comp. Mar. 1991 457 p Workshop held in Williamsburg, VA, 11-13 Jul. 1990
(NASA-CP-10065-Pt-1; NAS 1.55:10065-Pt-1) Avail: NTIS HC/MF A20 CSCL 22B

The proceedings of the workshop are presented. Some areas of discussion are as follows: modeling, systems identification, and control of flexible aircraft, spacecraft, and robotic systems. For individual titles, see N91-22308 through N91-22330.

N91-22308*# Rockwell International Science Center, Thousand Oaks, CA.
SPILLOVER, NONLINEARITY, AND FLEXIBLE STRUCTURES
Robert W. Bass and Dean Zes (McDonnell-Douglas Helicopter Co., Mesa, AZ.) *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 1-14 (For primary document see N91-22307 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

Many systems whose evolution in time is governed by Partial Differential Equations (PDEs) are linearized around a known equilibrium before Computer Aided Control Engineering (CACE) is considered. In this case, there are infinitely many independent vibrational modes, and it is intuitively evident on physical grounds that infinitely many actuators would be needed in order to control all modes. A more precise, general formulation of this grave difficulty (spillover problem) is due to A.V. Balakrishnan. A possible route to circumvention of this difficulty lies in leaving the PDE in its original nonlinear form, and adding the essentially finite dimensional control action prior to linearization. One possibly applicable technique is the Liapunov Schmidt rigorous reduction of singular infinite dimensional implicit function problems to finite dimensional implicit function problems. Omitting details of Banach space rigor, the formalities of this approach are given. Author

N91-22309*# Temple Univ., Philadelphia, PA. Dept. of Electrical Engineering.
STABILIZATION OF LARGE SPACE STRUCTURES BY LINEAR RELUCTANCE ACTUATORS
Saroj K. Biswas and Henry M. Sendaula *In* NASA. Langley

Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 15-21 (For primary document see N91-22307 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

Application of magnetic forces are considered for stabilization of vibrations of flexible space structures. Three electromagnetic phenomena are studied, such as: (1) magnetic body force; (2) reluctance torque; and (3) magnetostriction, and their application is analyzed for stabilization of a beam. The magnetic body force actuator uses the force that exists between poles of magnets. The reluctance actuator is configured in such a way that the reluctance of the magnetic circuit will be minimum when the beam is straight. Any bending of the beam increases the reluctance and hence generates a restoring torque that reduces bending. The gain of the actuator is controlled by varying the magnetizing current. Since the energy density of a magnetic device is much higher compared to piezoelectric or thermal actuators, it is expected that the reluctance actuator will be more effective in controlling the structural vibrations. Author

N91-22310*# Howard Univ., Washington, DC. Dept. of Electrical Engineering.
OPTIMAL CONTROL OF SYSTEMS WITH CAPACITY: RELATED NOISES **c63**
Milfang Ruan and Ajit K. Choudhury *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 23-34 (For primary document see N91-22307 14-18)
Avail: NTIS HC/MF A20 CSCL 09B

In the ordinary theory of optimal control (LQR and Kalman filter), the variances of the actuators and the sensors are assumed to be known (not related to the capacities of the devices). This assumption is not true in practice. Generally, a device with greater capacity to exert actuating forces and a sensor capable of sensing greater sensing range will generate noise of greater power spectral density. When the ordinary theory of optimal control is used to estimate the errors of the outputs in such cases it will lead to faulty results, because the capacities of such devices are unknown before the system is designed. The performance of the system designed by the ordinary theory will not be optimal as the variances of the sensors and the actuators are neither known nor constant. The interaction between the control system and structure could be serious because the ordinary method will lead to greater feedback (Kalman gain) matrices. Methods which can optimize the performance of systems when noises of the actuators and the sensors are related to their capacities are developed. These methods will result in smaller feedback (Kalman gain) matrix. Author

N91-22311*# Illinois Univ., Chicago. Dept. of Mathematics, Statistics, and Computer Science.
QUERYING DATABASES OF TRAJECTORIES OF DIFFERENTIAL EQUATIONS 2: INDEX FUNCTIONS **c13**
Robert Grossman *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 35-39 Sponsored in part by Laboratory for Advanced Computing (For primary document see N91-22307 14-18)
(Grants NAG2-513; NSF DMS-89-04740)
Avail: NTIS HC/MF A20 CSCL 22A

Suppose that a large number of parameterized trajectories (gamma) of a dynamical system evolving in R sup N are stored in a database. Let eta is contained R sup N denote a parameterized path in Euclidean space, and let parallel to center dot parallel to denote a norm on the space of paths. A data structures and indices for trajectories are defined and algorithms are given to answer queries of the following forms: Query 1. Given a path eta, determine whether eta occurs as a subtrajectory of any trajectory gamma from the database. If so, return the trajectory; otherwise, return null. Query 2. Given a path eta, return the trajectory gamma from the database which minimizes the norm parallel to eta - gamma parallel. Author

N91-22312*# Colorado State Univ., Fort Collins.
A FAST ALGORITHM FOR CONTROL AND ESTIMATION USING A POLYNOMIAL STATE-SPACE STRUCTURE **c61**
James R. Shults, Thomas Brubaker, and Gordon K. F. Lee (North Carolina State Univ., Raleigh.) *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 41-56 (For primary document see N91-22307 14-18)
(Grant NAG1-926)
Avail: NTIS HC/MF A20 CSCL 09B

One of the major problems associated with the control of flexible structures is the estimation of system states. Since the parameters of the structures are not constant under varying loads and conditions, conventional fixed parameter state estimators can not be used to effectively estimate the states of the system. One alternative is to use a state estimator which adapts to the condition of the system. One such estimator is the Kalman filter. This filter is a time varying recursive digital filter which is based upon a model of the system being measured. This filter adapts the model according to the output of the system. Previously, the Kalman filter has only been used in an off-line capacity due to the computational time required for implementation. With recent advances in computer technology, it is becoming a viable tool for use in the on-line environment. A distributed Kalman filter implementation is described for fast estimation of the state of a flexible arm. A key issue, is the sensor structure and initial work on a distributed sensor that could be used with the Kalman filter is presented. Author

N91-22313*# Illinois Univ., Chicago. Lab. for Advanced Computing.
SUPERCOMPUTER OPTIMIZATIONS FOR STOCHASTIC OPTIMAL CONTROL APPLICATIONS **c63**
Siu-Leung Chung, Floyd B. Hanson, and Huihuang Xu *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 57-70 Sponsored in part by ANL (For primary document see N91-22307 14-18)
(Grant NSF DMS-88-06099)
Avail: NTIS HC/MF A20 CSCL 09B

Supercomputer optimizations for a computational method of solving stochastic, multibody, dynamic programming problems are presented. The computational method is valid for a general class of optimal control problems that are nonlinear, multibody dynamical systems, perturbed by general Markov noise in continuous time, i.e., nonsmooth Gaussian as well as jump Poisson random white noise. Optimization techniques for vector multiprocessors or vectorizing supercomputers include advanced data structures, loop restructuring, loop collapsing, blocking, and compiler directives. These advanced computing techniques and superconducting hardware help alleviate Bellman's curse of dimensionality in dynamic programming computations, by permitting the solution of large multibody problems. Possible applications include lumped flight dynamics models for uncertain environments, such as large scale and background random aerospace fluctuations. Author

N91-22314*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A FAST, RELIABLE ALGORITHM FOR COMPUTING FREQUENCY RESPONSES OF STATE SPACE MODELS **c61**
Matt Wette *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 71-78 (For primary document see N91-22307 14-18)
Avail: NTIS HC/MF A20 CSCL 09B

Computation of frequency responses for large order systems described by time invariant state space systems often provides a bottleneck in control system analysis. It is shown that banding the A-matrix in the state space model can effectively reduce the computation time for such systems while maintaining reliability in the results produced. Author

N91-22315*# Lockheed Missiles and Space Co., Sunnyvale, CA.

COUPLED RICCATI EQUATIONS FOR COMPLEX PLANE CONSTRAINT

Kristin M. Strong and John R. Sesak *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 79-90 (For primary document see N91-22307 14-18)

Avail: NTIS HC/MF A20 CSCL 22B

A new Linear Quadratic Gaussian design method is presented which provides prescribed imaginary axis pole placement for optimal control and estimation systems. This procedure contributes another degree of design freedom to flexible spacecraft control. Current design methods which interject modal damping into the system tend to have little affect on modal frequencies, i.e., they predictably shift open plant poles horizontally in the complex plane to form the closed loop controller or estimator pole constellation, but make little provision for vertical (imaginary axis) pole shifts. Imaginary axis shifts which reduce the closed loop model frequencies (the bandwidths) are desirable since they reduce the sensitivity of the system to noise disturbances. The new method drives the closed loop modal frequencies to predictable (specified) levels, frequencies as low as zero rad/sec (real axis pole placement) can be achieved. The design procedure works through rotational and translational destabilizations of the plant, and a coupling of two independently solved algebraic Riccati equations through a structured state weighting matrix. Two new concepts, gain transference and Q equivalency, are introduced and their use shown. Author

N91-22316*# Purdue Univ., West Lafayette, IN.

OPTIMAL CONTROLLERS FOR FINITE WORDLENGTH IMPLEMENTATION **c60**

K. Liu and R. Skelton *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 91-132 (For primary document see N91-22307 14-18)

(Grant NAG1-857)

Avail: NTIS HC/MF A20 CSCL 09B

When a controller is implemented in a digital computer, with A/D and D/A conversion, the numerical errors of the computation can drastically affect the performance of the control system. There exists realizations of a given controller transfer function yielding arbitrarily large effects from computational errors. Since, in general, there is no upper bound, it is important to have a systematic way of reducing these effects. Optimum controller designs are developed which take account of the digital round-off errors in the controller implementation and in the A/D and D/A converters. These results provide a natural extension to the Linear Quadratic Gaussian (LQG) theory since they reduce to the standard LQG controller when infinite precision computation is used. But for finite precision the separation principle does not hold. Author

N91-22317*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

SYSTEM DYNAMIC SIMULATION OF PRECISION SEGMENTED REFLECTOR

Choon-Foo Shih and Michael C. Lou *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 133-144 (For primary document see N91-22307 14-18)

Avail: NTIS HC/MF A20 CSCL 22B

A joint effort was undertaken on a Precision Segmented Reflector (PSR) Project. The missions in which the PSR is to be used will use large (up to 20 m in diameter) telescopes. The essential requirement for the telescopes is that the reflector surface of the primary mirror must be made extremely precise to allow no more than a few microns of errors and, additionally, this high surface precision must be maintained when the telescope is subjected to on-orbital mechanical and thermal disturbances. Based on the mass, size, and stability considerations, reflector surface formed by segmented, probably actively or passively controlled, composite panels are regarded as most suitable for future space based astronomical telescope applications. In addition to the design and fabrication of composite panels with a surface error of less than 3 microns RMS, PSR also develops related reflector structures, materials, control, and sensing technologies. As part of the planning effort for PSR Technology Demonstration, a system model which couples the reflector, consisting of panels, support truss and actuators, and the optical bench was assembled for dynamic simulations. Random vibration analyses using seismic data obtained from actual measurements at the test site designated for PSR Technology Demonstration are described. Author

N91-22318*# Lockheed Aeronautical Systems Co., Burbank, CA.

FLEXIBLE BODY DYNAMIC STABILITY FOR HIGH PERFORMANCE AIRCRAFT **c05**

E. A. Goforth, H. M. Youssef, C. V. Apelian, and S. C. Schroeder *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 145-155 (For primary document see N91-22307 14-18)

Avail: NTIS HC/MF A20 CSCL 01C

Dynamic equations which include the effects of unsteady aerodynamic forces and a flexible body structure were developed for a free flying high performance fighter aircraft. The linear and angular deformations are assumed to be small in the body reference frame, allowing the equations to be linearized in the deformation variables. Equations for total body dynamics and flexible body dynamics are formulated using the hybrid coordinate method and integrated in a state space format. A detailed finite element model of a generic high performance fighter aircraft is used to generate the mass and stiffness matrices. Unsteady aerodynamics are represented by a rational function approximation of the doublet lattice matrices. The equations simplify for the case of constant angular rate of the body reference frame, allowing the effect of roll rate to be studied by computing the eigenvalues of the system. It is found that the rigid body modes of the aircraft are greatly affected by introducing a constant roll rate, while the effect on the flexible modes is minimal for this configuration. Author

N91-22319*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Engineering Science and Mechanics.

A RECURSIVE APPROACH TO THE EQUATIONS OF MOTION FOR THE MANEUVERING AND CONTROL OF FLEXIBLE MULTI-BODY SYSTEMS

Moon K. Kwak and Leonard Meirovitch *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 157-179 (For primary document see N91-22307 14-18)

(Contract F49620-89-C-0049)

Avail: NTIS HC/MF A20 CSCL 22B

Interest lies in a mathematical formulation capable of accommodating the problem of maneuvering a space structure consisting of a chain of articulated flexible substructures. Simultaneously, any perturbations from the 'rigid body' maneuvering and any elastic vibration must be suppressed. The equations of motion for flexible bodies undergoing rigid body motions and elastic vibrations can be obtained conveniently by means of Lagrange's equations in terms of quasi-coordinates. The advantage of this approach is that it yields equations in terms of body axes, which are the same axes that are used to express the control forces and torques. The equations of motion are nonlinear hybrid differential quations. The partial differential equations can be discretized (in space) by means of the finite element method or the classical Rayleigh-Ritz method. The result is a set of nonlinear ordinary differential equations of high order. The nonlinearity can be traced to the rigid body motions and the high order to the elastic vibration. Elastic motions tend to be small when compared with rigid body motions. Author

N91-22320*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

SERIAL AND PARALLEL COMPUTATION OF KANE'S EQUATIONS FOR MULTIBODY DYNAMICS **c61**

Amir Fijany *In* NASA. Langley Research Center, Fourth NASA

Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 181-210 (For primary document see N91-22307 14-18)
Avail: NTIS HC/MF A20 CSCL 09B

The analysis of the efficiency of algorithms resulting from Kane's Equation for serial and parallel computation of mass matrix is examined. The algorithms resulting from Kane's equation and Modified Kane's equations are detailed. An analysis was made of two classes of algorithms for computation of mass matrix: the Newton-Euler based algorithms and the Composite rigid body algorithms. An analysis was also made of the efficiency of different algorithms for serial and parallel computations. Conclusions are drawn and presented. Author

N91-22321*# DYNACS Engineering Co., Inc., Clearwater, FL.
A GENERIC MULTI-FLEX-BODY DYNAMICS, CONTROLS SIMULATION TOOL FOR SPACE STATION
Ken W. London, John F. Lee, Ramen P. Singh, and Buddy Schubele *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 211-230 Prepared for Honeywell, Inc., Clearwater, FL (For primary document see N91-22307 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

An order (n) multiflex body Space Station simulation tool is introduced. The flex multibody modeling is generic enough to model all phases of Space Station from build up through to Assembly Complete configuration and beyond. Multibody subsystems such as the Mobile Servicing System (MSS) undergoing a prescribed translation and rotation are also allowed. The software includes aerodynamic, gravity gradient, and magnetic field models. User defined controllers can be discrete or continuous. Extensive preprocessing of 'body by body' NASTRAN flex data is built in. A significant aspect, too, is the integrated controls design capability which includes model reduction and analytic linearization. Author

N91-22322*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN INTEGRATED CONTROL/STRUCTURE DESIGN METHOD USING MULTI-OBJECTIVE OPTIMIZATION
Sandeep Gupta (Vigyan Research Associates, Inc., Hampton, VA.) and Suresh M. Joshi *In its* Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 231-25 (For primary document see N91-22307 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

The benefits are demonstrated of a multiobjective optimization based control structure integrated design methodology. An application of the proposed CSI methodology to the integrated design of the Spacecraft COntrol Lab Experiment (SCOLE) configuration is presented. Integrated design resulted in reducing both the control performance measure and the mass. Thus, better overall performance is achieved through integrated design optimization. The mutliobjective optimization approach used provides Pareto optimal solutions by unconstrained minimization of a differentiable KS function. Furthermore, adjusting the parameters gives insight into the trade-offs involved between different objectives. Author

N91-22323*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMBINED STRUCTURES-CONTROLS OPTIMIZATION OF LATTICE TRUSSES
A. V. Balakrishnan *In its* Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 253-29 (For primary document see N91-22307 14-18)
(Contract NAS1-18585)
Avail: NTIS HC/MF A20 CSCL 22B

The role that distributed parameter model can play in CSI is demonstrated, in particular in combined structures controls optimization problems of importance in preliminary design. Closed form solutions can be obtained for performance criteria such as rms attitude error, making possible analytical solutions of the optimization problem. This is in contrast to the need for numerical computer solution involving the inversion of large matrices in traditional finite element model (FEM) use. Another advantage of the analytic solution is that it can provide much needed insight into phenomena that can otherwise be obscured or difficult to discern from numerical computer results. As a compromise in level of complexity between a toy lab model and a real space structure, the lattice truss used in the EPS (Earth Pointing Satellite) was chosen. The optimization problem chosen is a generic one: of minimizing the structure mass subject to a specified stability margin and to a specified upper bond on the rms attitude error, using a co-located controller and sensors. Standard FEM treating each bar as a truss element is used, while the continuum model is anisotropic Timoshenko beam model. Performance criteria are derived for each model, except that for the distributed parameter model, explicit closed form solutions was obtained. Numerical results obtained by the two model show complete agreement. Author

N91-22324*# Hughes Aircraft Co., El Segundo, CA.
CONTROL AND DYNAMICS OF A FLEXIBLE SPACECRAFT DURING STATIONKEEPING MANEUVERS
D. Liu, J. Yocum, and D. S. Kang (Draper, Charles Stark Lab., Inc., Cambridge, MA) *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 291-330 Sponsored in part by Draper (Charles Stark) Lab., Inc., Cambridge MA (For primary document see N91-22307 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

A case study of a spacecraft having flexible solar arrays is presented. A stationkeeping attitude control mode using both earth and rate gyro reference signals and a flexible vehicle dynamics modeling and implementation is discussed. The control system is designed to achieve both pointing accuracy and structural mode stability during stationkeeping maneuvers. Reduction of structural mode interactions over the entire mode duration is presented. The control mode using a discrete time observer structure is described to show the convergence of the spacecraft attitude transients during Delta-V thrusting maneuvers without preloading thrusting bias to the onboard control processor. The simulation performance using the three axis, body stabilized nonlinear dynamics is provided. The details of a five body dynamics model are discussed. The spacecraft is modeled as a central rigid body having cantilevered flexible antennas, a pair of flexible articulated solar arrays, and to gimballed momentum wheels. The vehicle is free to undergo unrestricted rotations and translations relative to inertial space. A direct implementation of the equations of motion is compared to an indirect implementation that uses a symbolic manipulation software to generate rigid body equations. Author

N91-22325*# Massachusetts Inst. of Tech., Cambridge.
TRANSFORM METHODS FOR PRECISION CONTINUUM AND CONTROL MODELS OF FLEXIBLE SPACE STRUCTURES
Victor D. Lupi, James D. Turner, and Hon M. Chun (Photon Research Associates, Inc., Cambridge, MA.) *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 331-340 Previously announced in IAA as A90-53029 (For primary document see N91-22307 14-18)
(Contract F49620-89-C-0082)
Avail: NTIS HC/MF A20 CSCL 22B

An open loop optimal control algorithm is developed for general flexible structures, based on Laplace transform methods. A distributed parameter model of the structure is first presented, followed by a derivation of the optimal control algorithm. The control inputs are expressed in terms of their Fourier series expansions, so that a numerical solution can be easily obtained. The algorithm deals directly with the transcendental transfer functions from control inputs to outputs of interest, and structural deformation penalties, as well as penalties on control effort, are included in the formulation. The algorithm is applied to several structures of increasing complexity to show its generality. Author

N91-22326*# SDRC, Inc., San Diego, CA.
STRUCTURAL REPRESENTATION FOR ANALYSIS OF A CONTROLLED STRUCTURE
Paul A. Blelloch *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 341-358 Sponsored by NASA. Lewis Research Center (For primary document see N91-22307 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

The purpose was to determine what reduced order structural representation is most appropriate for coupling with a control system. The goal was to choose a reduced order structural model which retains as closely as possible the characteristics of the closed loop model with a full order structural representation. By characteristics of the closed loop model, it is meant that the closed loop eigenvalues and the closed loop transfer functions from commands to loads and from commands to response. This process does not address the accuracy of the full order model (usually a finite element model) but only the loss of accuracy associated with reducing th model. For the purposes of this study, only collocated sensors and actuators are examined. The choice of a structural representation for noncollocated sensors and actuators is not so clear. Author

N91-22327*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PDEMOD: SOFTWARE FOR CONTROL/STRUCTURES OPTIMIZATION c61
Lawrence W. Taylor, Jr. and David Zimmerman (Florida Univ., Gainesville.) *In its* Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 359-39 (For primary document see N91-22307 14-18)
Avail: NTIS HC/MF A20 CSCL 09B

Because of the possibility of adverse interaction between the control system and the structural dynamics of large, flexible spacecraft, great care must be taken to ensure stability and system performance. Because of the high cost of insertion of mass into low earth orbit, it is prudent to optimize the roles of structure and control systems simultaneously. Because of the difficulty and the computational burden in modeling and analyzing the control structure system dynamics, the total problem is often split and treated iteratively. It would aid design if the control structure system dynamics could be represented in a single system of equations. With the use of the software PDEMOD (Partial Differential Equation Model), it is now possible to optimize structure and control systems simultaneously. The distributed parameter modeling approach enables embedding the control system dynamics into the same equations for the structural dynamics model. By doing this, the current difficulties involved in model order reduction are avoided. The NASA Mini-MAST truss is used an an example for studying integrated control structure design. Author

N91-22328*# Howard Univ., Washington, DC. Dept. of Mechanical Engineering.
MANEUVER SIMULATIONS OF FLEXIBLE SPACECRAFT BY SOLVING TPBVP
Peter M. Bainum and Feiyue Li *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 393-418 (For primary document see N91-22307 14-18)
(Grant NsG-1414)
Avail: NTIS HC/MF A20 CSCL 22B

The optimal control of large angle rapid maneuvers and vibrations of a Shuttle mast reflector system is considered. The nonlinear equations of motion are formulated by using Lagrange's formula, with the mast modeled as a continuous beam. The nonlinear terms in the equations come from the coupling between the angular velocities, the modal coordinates, and the modal rates. Pontryagin's Maximum Principle is applied to the slewing problem, to derive the necessary conditions for the optimal controls, which are bounded by given saturation levels. The resulting two point boundary value problem (TPBVP) is then solved by using the quasilinearization algorithm and the method of particular solutions. In the numerical simulations, the structural parameters and the control limits from the Spacecraft Control Lab Experiment (SCOLE) are used. In the 2-D case, only the motion in the plane of an Earth orbit or the single axis slewing motion is discussed. In the 3-D slewing, the mast is modeled as a continuous beam subjected to 3-D deformations. The numerical results for both the linearized system and the nonlinear system are presented to compare the differences in their time response. Author

N91-22329*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.
CONTROL EFFORT ASSOCIATED WITH MODEL REFERENCE ADAPTIVE CONTROL FOR VIBRATION DAMPING c63
Richard Scott Messer and Raphael T. Haftka *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 419-441 (For primary document see N91-22307 14-18)
(Grant NAG1-603)
Avail: NTIS HC/MF A20 CSCL 09B

The performance of Model Reference Adaptive Control (MRAC) is studied in numerical simulations with the objective of understanding the effects of differences between the plant and the reference model. MRAC is applied to two structural systems with adjustable error between the reference model and the actual plant. Performance indices relating to control effort and response characteristics are monitored in order to determine what effects small errors have on the control effort and performance of the two systems. It is shown that reasonable amounts of error in the reference model can cause dramatic increases in both the control effort and response magnitude (as measured by energy integrals) of the plant. Author

N91-22330*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
COMPONENT MODE DAMPING ASSIGNMENT TECHNIQUES
Allan Y. Lee *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 443-457 (For primary document see N91-22307 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

A relation between the system modal damping matrix and the component modal damping matrix is derived from First Principles. An optimization problem is then formulated to select all the component modes' damping ratios that best satisfy the above derived relation. A weighting matrix is used in the cost functional to stress the relative importance of the diagonal terms in the damping matrix. Inequality constraints are also added to the optimization problem to pick only nonnegative component modes' damping factors. The optimization problem may be solved algebraically or iteratively. The proposed techniques are successfully used on a high order, finite element model of the Galileo spacecraft. Author

N91-22331*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FOURTH NASA WORKSHOP ON COMPUTATIONAL CONTROL OF FLEXIBLE AEROSPACE SYSTEMS, PART 2
Lawrence W. Taylor, Jr., comp. Mar. 1991 464 p Workshop held in Williamsburg, VA, 11-13 Jul. 1990
(NASA-CP-10065-Pt-2; NAS 1.55:10065-Pt-2) Avail: NTIS HC/MF A20 CSCL 22B

A collection of papers presented at the Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems is given. The papers address modeling, systems identification, and control of flexible aircraft, spacecraft and robotic systems. For individual titles, see N91-22332 through N91-22351.

N91-22332*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN OVERVIEW OF THE ACTIVE FLEXIBLE WING PROGRAM c08
Stanley R. Cole, Boyd Perry, III, and Gerald D. Miller (Rockwell International Corp., Los Angeles, CA.) *In its* Fourth NASA

Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 459-49 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 01C

An outline of the Active Flexible Wing (AFW) project that was meant to serve as an introduction to an entire session of the Computational Control Workshop is presented. Following background information on the project is a description of the AFW wind tunnel model and results from the initial wind tunnel test of the AFW model under the current project. Emphasis is on major project accomplishments. The AFW project is an effort to demonstrate aeroelastic control through the application of digital controls technology. Active flutter suppression and active control of maneuver loads during high speed rolling maneuvers are examined. Author

N91-22333*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AEROELASTIC MODELING OF THE ACTIVE FLEXIBLE WING WIND-TUNNEL MODEL **c05**
Walter A. Silva (Lockheed Engineering and Sciences Co., Hampton, VA.), Jennifer Heeg, and Robert M. Bennett *In its* Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 497-53 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 01C

The primary issues involved in the generation of linear, state-space equations of motion of a flexible wind tunnel model, the Active Flexible Wing (AFW), are discussed. The codes that were used and their inherent assumptions and limitations are also briefly discussed. The application of the CAP-TSD code to the AFW for determination of the model's transonic flutter boundary is included as well. Author

N91-22334*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DESIGN AND TEST OF THREE ACTIVE FLUTTER SUPPRESSION CONTROLLERS **c08**
David M. Christhilf, Martin R. Waszak, William M. Adams, S. Srinathkumar (National Aeronautical Lab., Bangalore, India), and Vivek Mukhopadhyay *In its* Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 535-56 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 01C

Three flutter suppression control law design techniques are presented. Each uses multiple control surfaces and/or sensors. The first uses linear combinations of several accelerometer signals together with dynamic compensation to synthesize the modal rate of the critical mode for feedback to distributed control surfaces. The second uses traditional tools (pole/zero loci and Nyquist diagrams) to develop a good understanding of the flutter mechanism and produce a controller with minimal complexity and good robustness to plant uncertainty. The third starts with a minimum energy Linear Quadratic Gaussian controller, applies controller order reduction, and then modifies weight and noise covariance matrices to improve multi-variable robustness. The resulting designs were implemented digitally and tested subsonically on the Active Flexible Wing (AFW) wind tunnel model. Test results presented here include plant characteristics, maximum attained closed-loop dynamic pressure, and Root Mean Square control surface activity. A key result is that simultaneous symmetric and antisymmetric flutter suppression was achieved by the second control law, with a 24 percent increase in attainable dynamic pressure. Author

N91-22335*# Rockwell International Corp., Los Angeles, CA.
ROLL PLUS MANEUVER LOAD ALLEVIATION CONTROL SYSTEM DESIGNS FOR THE ACTIVE FLEXIBLE WING WIND-TUNNEL MODEL **c08**
Douglas B. Moore, Gerald D. Miller, and Martin J. Klepl *In* NASA, Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 561-582 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 01C

Three designs for controlling loads while rolling for the Active Flexible Wing (AFW) are discussed. The goal is to provide good roll control while simultaneously limiting the torsion and bending loads experienced by the wing. The first design uses Linear Quadratic Gaussian/Loop Transfer Recovery (LQG/LTR) modern control methods to control roll rate and torsional loads at four different wing locations. The second design uses a nonlinear surface command function to produce surface position commands as a function of current roll rate and commanded roll rate. The final design is a flutter suppression control system. This system stabilizes both symmetric and axisymmetric flutter modes of the AFW. Author

N91-22336*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DEVELOPMENT, SIMULATION VALIDATION, AND WIND TUNNEL TESTING OF A DIGITAL CONTROLLER SYSTEM FOR FLUTTER SUPPRESSION **c08**
Sherwood Tiffany Hoadley, Carey S. Buttrill, Sandra M. McGraw (Lockheed Engineering and Sciences Co., Hampton, VA.), and Jacob A. Houck *In its* Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 583-61 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 01C

Flutter suppression (FS) is one of the active control concepts being investigated by the AFW program. The design goal for FS control laws was to increase the passive flutter dynamic pressure by 30 percent. In order to meet this goal, the FS control laws had to be capable of suppressing both symmetric and antisymmetric flutter instabilities simultaneously. In addition, the FS control laws had to be practical and low-order, robust and capable of real time execution within the 200 hz. sampling time. The purpose here is to present an overview of the development, simulation validation, and wind tunnel testing of a digital controller system for flutter suppression. Author

N91-22337*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DEVELOPMENT AND TESTING OF CONTROLLER PERFORMANCE EVALUATION METHODOLOGY FOR MULTI-INPUT/MULTI-OUTPUT DIGITAL CONTROL SYSTEMS **c08**
Anthony Pototzky (Lockheed Engineering and Sciences Co., Hampton, VA.), Carol Wieseman, Sherwood Tiffany Hoadley, and Vivek Mukhopadhyay *In its* Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 615-65 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 01C

Described here is the development and implementation of on-line, near real time controller performance evaluation (CPE) methods capability. Briefly discussed are the structure of data flow, the signal processing methods used to process the data, and the software developed to generate the transfer functions. This methodology is generic in nature and can be used in any type of multi-input/multi-output (MIMO) digital controller application, including digital flight control systems, digitally controlled spacecraft structures, and actively controlled wind tunnel models. Results of applying the CPE methodology to evaluate (in near real time) MIMO digital flutter suppression systems being tested on the Rockwell Active Flexible Wing (AFW) wind tunnel model are presented to demonstrate the CPE capability. Author

N91-22338*# Cincinnati Univ., OH.
ACTIVE VERSUS PASSIVE DAMPING IN LARGE FLEXIBLE STRUCTURES
Gary L. Slater and Mark D. McLaren (Ford Aerospace Corp., Palo Alto, CA.) *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 655-661 Sponsored in part by

AFOSR and Cray Research, Inc. (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

Optimal passive and active damping control can be considered in the context of a general control/structure optimization problem. Using a mean square output response approach, it is shown that the weight sensitivity of the active and passive controllers can be used to determine an optimal mix of active and passive elements in a flexible structure. Author

N91-22339*# Buffalo Univ., NY. Dept. of Mechanical and Aerospace Engineering.
VIBRATION SUPPRESSION AND SLEWING CONTROL OF A FLEXIBLE STRUCTURE
Daniel J. Inman, Ephrahim Garcia, and Brett Pokines *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 663-671 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

Examined here are the effects of motor dynamics and secondary piezoceramic actuators on vibration suppression during the slewing of flexible structures. The approach focuses on the interaction between the structure, the actuators, and the choice of control law. The results presented here are all simulated, but are based on experimentally determined parameters for the motor, structure, piezoceramic actuators, and piezofilm sensors. The simulation results clearly illustrate that the choice of motor inertia relative to beam inertia makes a critical difference in the performance of the system. In addition, the use of secondary piezoelectric actuators reduces the load requirements on the motor and also reduces the overshoot of the tip deflection. The structures considered here are a beam and a frame. The majority of results are based on a Euler Bernoulli beam model. The slewing frame introduces substantial torsional modes and a more realistic model. The slewing frame results are incomplete and represent work in progress. Author

N91-22340*# Buffalo Univ., NY. Dept. of Mechanical and Aerospace Engineering.
CANDIDATE PROOF MASS ACTUATOR CONTROL LAWS FOR THE VIBRATION SUPPRESSION OF A FRAME
Jeffrey W. Umland and Daniel J. Inman *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 672-690 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

The vibration of an experimental flexible space truss is controlled with internal control forces produced by several proof mass actuators. Four candidate control law strategies are evaluated in terms of performance and robustness. These control laws are experimentally implemented on a quasi free-free planar truss. Sensor and actuator dynamics are included in the model such that the final closed loop is self-equilibrated. The first two control laws considered are based on direct output feedback and consist of tuning the actuator feedback gains to the lowest mode intended to receive damping. The first method feeds back only the position and velocity of the proof mass relative to the structure; this results in a traditional vibration absorber. The second method includes the same feedback paths as the first plus feedback of the local structural velocity. The third law is designed with robust H infinity control theory. The fourth strategy is an active implementation of a viscous damper, where the actuator is configured to provide a bending moment at two points on the structure. The vibration control system is then evaluated in terms of how it would benefit the space structure's position control system. Author

N91-22341*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SIMULATOR EVALUATION OF SYSTEM IDENTIFICATION WITH ON-LINE CONTROL LAW UPDATE FOR THE CONTROLS AND ASTROPHYSICS EXPERIMENT IN SPACE
Raymond C. Montgomery, Dave Ghosh, Michael A. Scott, and Dirk Warnaar (Lockheed Engineering and Sciences Co., Hampton, VA.) *In its* Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 691-72 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

A procedure for optimizing the performance of large flexible spacecraft that require active vibration suppression to achieve required performance is presented. The procedure is to conduct on-orbit testing and system identification followed by a control system design. It is applied via simulation to a spacecraft configuration currently being considered for flight test by NASA - the Controls, Astrophysics, and Structures Experiment in Space (CASES). The system simulator is based on a NASTRAN finite element structural model. A finite number of modes is used to represent the structural dynamics. The system simulator also includes models of the electronics, actuators, sensors, the digital controller, and the internal and external disturbances. Nonlinearities caused by quantization are included in the study to examine tolerance of the procedure to modelling errors. Disturbance and sensor noise is modelled as a Gaussian process. For system identification, the system is excited using sinusoidal inputs at the resonant frequencies of the structure using each actuator. Mode shapes, frequencies, and damping ratios are identified from the unforced response sensor data after each excitation. Then, the excitation data is used to identify the actuator influence coefficients. The results of the individual parameter identification analyses are assembled into an aggregate system model. The control design is accomplished based only on the identified model using multi-input/output linear quadratic Gaussian theory. Its performance is evaluated based on time-to-damp as compared with the uncontrolled structure. Author

N91-22342*# Carleton Univ., Ottawa (Ontario). Dept. of Mechanical and Aerospace Engineering.
DYNAMICS MODELING AND ADAPTIVE CONTROL OF FLEXIBLE MANIPULATORS **c63**
J. Z. Sasiadek *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 727-741 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 09B

An application of Model Reference Adaptive Control (MRAC) to the position and force control of flexible manipulators and robots is presented. A single-link flexible manipulator is analyzed. The problem was to develop a mathematical model of a flexible robot that is accurate. The objective is to show that the adaptive control works better than 'conventional' systems and is suitable for flexible structure control. Author

N91-22343*# Harris Corp., Melbourne, FL. Goverment Aerospace Systems Div.
ACTIVE AND PASSIVE VIBRATION SUPPRESSION FOR SPACE STRUCTURES
David C. Hyland *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 743-779 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

The relative benefits of passive and active vibration suppression for large space structures (LSS) are discussed. The intent is to sketch the true ranges of applicability of these approaches using previously published technical results. It was found that the distinction between active and passive vibration suppression approaches is not as sharp as might be thought at first. The relative simplicity, reliability, and cost effectiveness touted for passive measures are vitiated by 'hidden costs' bound up with detailed engineering implementation issues and inherent performance limitations. At the same time, reliability and robustness issues are often cited against active control. It is argued that a continuum of vibration suppression measures offering mutually supporting capabilities is needed. The challenge is to properly orchestrate a spectrum of methods to reap the synergistic benefits

of combined advanced materials, passive damping, and active control. Author

N91-22344*# Grumman Aerospace Corp., Bethpage, NY.
REAL TIME DIGITAL CONTROL AND CONTROLLED STRUCTURES EXPERIMENTS
Michael J. Rossi, Gareth J. Knowles, and Frank Rauch *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 781-794 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

Viewgraphs covering the following topics are given: controlled structures technology at Grumman Corporate Research Center, active and passive control technology, experiment plans, and vacuum chamber test experiment objectives and setup. Author

N91-22345*# Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.
FINITE ELEMENT MODELING OF TRUSS STRUCTURES WITH FREQUENCY-DEPENDENT MATERIAL DAMPING
George A. Lesieutre *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 795-811 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

A physically motivated modelling technique for structural dynamic analysis that accommodates frequency dependent material damping was developed. Key features of the technique are the introduction of augmenting thermodynamic fields (AFT) to interact with the usual mechanical displacement field, and the treatment of the resulting coupled governing equations using finite element analysis methods. The AFT method is fully compatible with current structural finite element analysis techniques. The method is demonstrated in the dynamic analysis of a 10-bay planar truss structure, a structure representative of those contemplated for use in future space systems. Author

N91-22346*# State Univ. of New York, Buffalo. Dept. of Mechanical and Aerospace Engineering.
AN EXPERIMENTAL STUDY OF NONLINEAR DYNAMIC SYSTEM IDENTIFICATION
Greselda I. Stry and D Mook, Joseph *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 813-823 Previously announced as N91-17089 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

A technique based on the Minimum Model Error optimal estimation approach is employed for robust identification of a nonlinear dynamic system. A simple harmonic oscillator with quadratic position feedback was simulated on an analog computer. With the aid of analog measurements and an assumed linear model, the Minimum Model Error Algorithm accurately identifies the quadratic nonlinearity. The tests demonstrate that the method is robust with respect to prior ignorance of the nonlinear system model and with respect to measurement record length, regardless of initial conditions. Author

N91-22347*# State Univ. of New York, Buffalo. Dept. of Mechanical and Aerospace Engineering.
TIME DOMAIN MODAL IDENTIFICATION/ESTIMATION OF THE MINI-MAST TESTBED
Michael J. Roemer and D. Joseph Mook *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 825-843 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

The Mini-Mast is a 20 meter long 3-dimensional, deployable/retractable truss structure designed to imitate future trusses in space. Presented here are results from a robust (with respect to measurement noise sensitivity), time domain, modal identification technique for identifying the modal properties of the Mini-Mast structure even in the face of noisy environments. Three testing/analysis procedures are considered: sinusoidal excitation near resonant frequencies of the Mini-Mast, frequency response function averaging of several modal tests, and random input excitation with a free response period. Author

N91-22348*# Scientific Systems, Inc., Woburn, MA.
AN OVERVIEW OF THE ESSENTIAL DIFFERENCES AND SIMILARITIES OF SYSTEM IDENTIFICATION TECHNIQUES
Raman K. Mehra *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 845-880 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

Information is given in the form of outlines, graphs, tables and charts. Topics include system identification, Bayesian statistical decision theory, Maximum Likelihood Estimation, identification methods, structural mode identification using a stochastic realization algorithm, and identification results regarding membrane simulations and X-29 flutter flight test data. Author

N91-22349*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LIKELIHOOD ESTIMATION FOR DISTRIBUTED PARAMETER MODELS FOR NASA MINI-MAST TRUSS
Ji-Yao Shen, Jen-Kuang Huang (Old Dominion Univ., Norfolk, VA.), and Lawrence W. Taylor, Jr. *In its* Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 881-90 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

A maximum likelihood estimation for distributed parameter models of large flexible structures was formulated. Distributed parameter models involve far fewer unknown parameters than independent modal characteristics or finite element models. The closed form solutions for the partial differential equations with corresponding boundary conditions were derived. The closed-form expressions of sensitivity functions led to highly efficient algorithms for analyzing ground or on-orbit test results. For an illustration of this approach, experimental data of the NASA Mini-MAST truss was used. The estimations of modal properties involve lateral bending modes and torsional modes. The results show that distributed parameter models are promising in the parameter estimation of large flexible structures. Author

N91-22350*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
SPATIAL OPERATOR APPROACH TO FLEXIBLE MULTIBODY SYSTEM DYNAMICS AND CONTROL
G. Rodriguez *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 907-919 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

The inverse and forward dynamics problems for flexible multibody systems were solved using the techniques of spatially recursive Kalman filtering and smoothing. These algorithms are easily developed using a set of identities associated with mass matrix factorization and inversion. These identities are easily derived using the spatial operator algebra developed by the author. Current work is aimed at computational experiments with the described algorithms and at modelling for control design of limber manipulator systems. It is also aimed at handling and manipulation of flexible objects. Author

N91-22351*# North Carolina Univ., Charlotte. Dept. of Electrical Engineering.
A MODEL FOR THE THREE-DIMENSIONAL SPACECRAFT CONTROL LABORATORY EXPERIMENT
Yogendra P. Kakad *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 921-932 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 22B

A model for the three-dimensional Spacecraft Control Laboratory Experiment (SCOLE) is developed. The objective behind this method of modelling is to utilize the basic partial differential equations of motion for this distributed parameter system and not to use the modal expansion in developing the model. The final model obtained is in terms of a transfer function matrix which relates the flexible mast parameters like displacement, slope, shear stress, etc. to external forces and moments. Author

N91-22352*# Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
EVALUATION PLAN FOR SPACE STATION NETWORK INTERFACE UNITS
Alfred C. Weaver Mar. 1990 80 p
(Contract NCC9-16)
(NASA-CR-188088; NAS 1.26:188088) Avail: NTIS HC/MF A05 CSCL 22B

Outlined here is a procedure for evaluating network interface units (NIUs) produced for the Space Station program. The procedures should be equally applicable to the data management system (DMS) testbed NIUs produced by Honeywell and IBM. The evaluation procedures are divided into four areas. Performance measurement tools are hardware and software that must be developed in order to evaluate NIU performance. Performance tests are a series of tests, each of which documents some specific characteristic of NIU and/or network performance. In general, these performance tests quantify the speed, capacity, latency, and reliability of message transmission under a wide variety of conditions. Functionality tests are a series of tests and code inspections that demonstrate the functionality of the particular subset of ISO protocols which have been implemented in a given NIU. Conformance tests are a series of tests which would expose whether or not selected features within the ISO protocols are present and interoperable. Author

N91-22353*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
EARTH OBSERVING SYSTEM: 1989 REFERENCE HANDBOOK
1989 68 p
(NASA-TM-104948; NAS 1.15:104948) Avail: NTIS HC/MF A04 CSCL 22B

NASA is studying a coordinated effort called the Mission to Planet Earth to understand global change. The goals are to understand the Earth as a system, and to determine those processes that contribute to the environmental balance, as well as those that may result in changes. The Earth Observing System (Eos) is the centerpiece of the program. Eos will create an integrated scientific observing system that will enable multidisciplinary study of the Earth including the atmosphere, oceans, land surface, polar regions, and solid Earth. Science goals, the Eos data and information system, experiments, measuring instruments, and interdisciplinary investigations are described. B.G.

N91-22354# Engineering Mechanics Association, Inc., Torrance, CA.
AIAA/AFOSR WORKSHOP ON MICROGRAVITY SIMULATION IN GROUND VALIDATION TESTING OF LARGE SPACE STRUCTURES Final Report, Sep. 1989 - Sep. 1990
Timothy K. Hasselman 15 Oct. 1990 33 p Workshop held in Denver, CO, 1-2 Nov. 1989
(Contract F49620-89-C-0130)
(AD-A231507; EMA-TR-90-1153; AFOSR-91-0040TR) Avail: NTIS HC/MF A03 CSCL 22/2

This report summarizes the proceedings of the Workshop on Microgravity Simulation in Ground Validation testing of Large Space Structures. The workshop was conceived and organized as a follow-on activity to an earlier study. The objective of the initial study was to provide a cursory review of available techniques against assessed needs in the specific area of dynamic testing of large structures. The intent of the workshop was to broaden the scope of this initial investigation by involving national experts in areas relevant to issues identified in the initial study. The workshop focused on present and future needs. An overview session covering both military and civil space objectives was followed by a session on Space Structures Experimental Programs and Facilities, sessions on On-orbit Dynamics Modeling and Simulation, and sessions on Advanced Suspension Devices and Systems. The workshop concluded with a panel discussion which addressed current issues and needs. GRA

N91-22355# RAND Corp., Santa Monica, CA.
THE FUTURE OF INTELSAT IN A COMPETITIVE ENVIRONMENT
Leland L. Johnson Dec. 1988 60 p Sponsored by State Dept., Washington, DC
(AD-A231540; RAND/N-2848-DOS/RC) Avail: NTIS HC/MF A04 CSCL 22/2

INTELSAT has been an important instrument of U.S. foreign policy because it has spread the benefits of advanced telecommunications technology to nations - especially the developing nations - throughout the world. Concerns have arisen about INTERSAT's ability to continue its role as global provider of service in the face of growing competition. In response to these concerns, this study examines the financial situation that INTELSAT may face as a consequence of competition with fiber optic cable and other satellite systems. This is an important area for investigation because it may suggest pricing strategies and other responses by INTELSAT that would strengthen its ability to compete in a rapidly changing market environment. Author

N91-22356# Institute for Defense Analyses, Alexandria, VA.
CALCULATION OF REENTRY-VEHICLE TEMPERATURE HISTORY Final Report, Jul. - Sep. 1990
Reinald G. Finke Sep. 1990 30 p
(Contract MDA903-89-C-0003)
(AD-A231552; AD-E501349; IDA-P-2395; IDA/HQ-90-35501)
Avail: NTIS HC/MF A03 CSCL 22/2

A procedure has been set up to calculate the transient temperature distribution on the surface of a reentry vehicle (RV), with simulation of aerodynamic heating in the free-molecule, transition, and laminar (continuum) flow regimes, one dimensional transient heat conduction into the heat shield, and reradiation. The procedure is exercised to determine the altitude dependence of the surface temperature at various points on a particular RV configuration for an example ballistic trajectory for a range of emissivities. GRA

N91-22357# Naval Postgraduate School, Monterey, CA.
SATELLITE CHARGE CONTROL WITH LITHIUM ION SOURCE AND ELECTRON EMISSION M.S. Thesis
Chong S. Ryu Dec. 1990 107 p
(AD-A231956) Avail: NTIS HC/MF A06 CSCL 22/1

A lithium ion source using thermal emission from a Beta-eucryptite structure was investigated as a possible control device for spacecraft charging. This source can be used for control of positively charged spacecraft potentials in sunlight and differentially charged spacecraft surfaces in shadow. The emission characteristics of lithium ion sources is studied in conjunction with two kinds of electron sources and spacecraft charge control is simulated. A 0.6 in. lithium ion source produced currents up to 33 micro Amps at a bias voltage of 100 V on the surface (strips) of the simulation body with extraction potentials of 200 V to the screen. Differential charging simulations produced currents up to 21 micro Amps on the rear strip of the simulation structure at a bias voltage of 250 V. A directly heated tungsten dispenser cathode and filament-type electron source were used to overcome space charge limiting effects. Space charge effects were studied with a 0.25 in. lithium ion source in conjunction with the tungsten dispenser cathode. The average increase in current was approx. 50 pct. Larger increases were found with the 0.6 in. lithium ion source, using the filament electron source. The greatest effects occurred for low extraction voltages (some what less than 20 V). A typical increase was 400 pct. at 10 V. The vacuum chamber system and geometries for the simulation and investigation were very simple.

However, the combined ion and electron sources could be used as a device for controlling a spacecraft potential in geosynchronous orbit. GRA

N91-22358*# Sverdrup Technology, Inc., Brook Park, OH.
USER'S MANUAL FOR THE HEAT PIPE SPACE RADIATOR DESIGN AND ANALYSIS CODE (HEPSPARC) Final Report
Donald C. Hainley Apr. 1991 91 p
(Contract NAS3-25266)
(NASA-CR-187067; E-5994; NAS 1.26:187067) Avail: NTIS HC/MF A05 CSCL 22B

A heat pipe space radiatior code (HEPSPARC), was written for the NASA Lewis Research Center and is used for the design and analysis of a radiator that is constructed from a pumped fluid loop that transfers heat to the evaporative section of heat pipes. This manual is designed to familiarize the user with this new code and to serve as a reference for its use. This manual documents the completed work and is intended to be the first step towards verification of the HEPSPARC code. Details are furnished to provide a description of all the requirements and variables used in the design and analysis of a combined pumped loop/heat pipe radiator system. A description of the subroutines used in the program is furnished for those interested in understanding its detailed workings. Author

N91-22359*# Astro Aerospace Corp., Carpinteria, CA.
INFLUENCE OF UTILITY LINES AND THERMAL BLANKETS ON THE DYNAMICS AND CONTROL OF SATELLITES WITH PRECISION POINTING REQUIREMENTS
Richard K. Miller, Mark W. Thomson, and John M. Hedgepeth Washington NASA May 1991 50 p
(Contract NAS1-18567)
(NASA-CR-4366; NAS 1.26:4366; AAC-TN-1161) Avail: NTIS HC/MF A03 CSCL 22B

Most spacecraft control design techniques, for situations in which control structures interaction is an important design consideration, require that the behavior of the spacecraft and its structure be very well known. Large multipurpose spacecraft such as the Space Station will have a larger portion of their mass (e.g., the utility lines) in the ill managed category. As an initial step to address this problem, a study was performed of the residual free vibrations of a rigid body with an appendage consisting of an initially slack string or membrane (utility or thermal blanket) after completing a slew reorientation maneuver. Parametric studies of the effects of the initial strain, both positive and negative, were studied, and results are presented in terms of nondimensional variables. The results indicate that the amplitude of free oscillations increases dramatically when the initial strain is made negative (slack initial behavior). This result is particularly significant for high pointing precision applications, such as the Large Deployable Reflector. Applications are provided for the selection of appropriate design tension for the LDR sunshade in a proposed baseline design. Author

N91-22360# Technische Univ., Delft (Netherlands).
SATELLITE ALTIMETER DATA PROCESSING: FROM THEORY TO PRACTICE Ph.D. Thesis
Reinier Cornelis Adr Zandbergen 1990 254 p Sponsored by Space Research Organization Netherlands
(ISBN-90-6275-653-0; ETN-91-99186) Copyright Avail: NTIS HC/MF A12

Satellite altimetry, the satellites involved and the problems in data processing are presented. An overview of altimetry related subjects is given. These include coordinates of earth and satellite, the radar height observation, the ocean, satellite orbit perturbations, the gravity field of the Earth, and altimetry products. The theory and practice of precise orbit determination is discussed under the following headings: orbit selection for altimetry satellites, precise orbit computation techniques, orbit computation techniques, orbit computation using altimeter data, analytical orbit perturbation theory, and gravity model tuning. ESA

N91-22361# Bristol Univ. (England). Dept. of Aerospace Engineering.
THE SPACE STATION AS A TRANSPORT NODE B.S. Thesis
D. Y. Maharaj and F. E. H. Miftach Jun. 1990 99 p
(BU-510; ETN-91-99203) Avail: NTIS HC/MF A05

The economic feasibility of a space station based comet nucleus sample return mission is investigated. The analysis evolves around launch and potential recovery to a space station. In order to do this, the scenario was compared to an Earth based mission. It was found that the overriding factor in the analysis were the launch costs, from which it was evident that conventional launches were not cost effective for transporting the hardware to the space station. However, with the advent of reusable launchers, space station based missions could prove to be more economical than Earth based missions. ESA

N91-22362# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Hubschrauber und Flugzeuge.
STRUCTURAL OPTIMIZATION WITH CONSTRAINTS FROM DYNAMICS IN LAGRANGE
Guenter Kneppe, F. Pfeiffer, and C. Ross (Technische Univ., Munich, Germany, F.R.) 5 Nov. 1990 9 p Presented at the 3rd Air Force/NASA Symposium on Recent Advances in Multidisciplinary Analysis and Optimization, San Francisco, CA, 24-26 Sep. 1990
(MBB-FW522/S/PUB/431; ETN-91-99251) Copyright Avail: NTIS HC/MF A02

Structural optimization problems are mostly solved under constraints fron statics, such as stresses, strains or displacements under static loads. But in the design process dynamic quantities like eigenfrequencies or accelerations under dynamic loads become more and more important. Therefore it is obvious that constraints from dynamics must be considered in structural optimization packages. The dynamics branch in LAGRANGE are addressed. Two topics, namely the different formulations for eigenfrequency constraints and frequency response constraints are focused upon. For the latter the necessity of a system reduction is emphasized. The methods implemented in LAGRANGE are presented and examples are given. ESA

N91-22363*# Alabama Univ., Tuscaloosa. Dept. of Engineering Mechanics.
MLIBlast: A PROGRAM TO EMPIRICALLY PREDICT HYPERVELOCITY IMPACT DAMAGE TO THE SPACE STATION Final Report
William K. Rule May 1991 191 p
(Grant NAG8-123)
(NASA-CR-184153; NAS 1.26:184153) Avail: NTIS HC/MF A09 CSCL 22B

MLIBlast is described, which consists of a number of DOC PC based Microsoft BASIC program modules written to provide spacecraft designers with empirical predictions of space debris damage to orbiting spacecraft. The Spacecraft wall configuration is assumed to consist of multilayer insulation (MLI) placed between a Whipple style bumper and a pressure wall. Predictions are based on data sets of experimental results obtained from simulating debris impact on spacecraft. One module of MLIBlast facilitates creation of the data base of experimental results that is used by the damage prediction modules of the code. The user has a choice of three different prediction modules to predict damage to the bumper, the MLI, and the pressure wall. Author

N91-22142*# Massachusetts Inst. of Tech., Cambridge.
PROPOSAL FOR A REMOTELY MANNED SPACE STATION
Marvin Minsky *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 58-67
(For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22B

N91-22168*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ADVANCED SPACECRAFT: WHAT WILL THEY LOOK LIKE AND WHY

Humphrey W. Price *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 371-390 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22B

N91-22169*# Rockwell International Corp., Downey, CA. Space Transportation Systems Div.
UNUSUAL SPACECRAFT MATERIALS
Jonathan V. Post *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 391-403 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 22B

N91-22224# Logica SA/NV, Brussels (Belgium).
MICROGRAVITY EXPERIMENT DESIGN
Geert Vansteenkiste and Luc Servranckx *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 207-212 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22290# European Space Agency. European Space Operations Center, Darmstadt (Germany, F.R.).
THE ESOC SPACECRAFT PERFORMANCE EVALUATION SYSTEM (SPES)
F. Sell and J. F. Kaufeler *In its* Ground Data Systems for Spacecraft Control Oct. 1990 p 631-634 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography.*

N91-22364*# Alabama Univ., Huntsville. Dept. of Physics.
ENGINEERING SUPPORT FOR AN ULTRAVIOLET IMAGER FOR THE ISTP MISSION
Douglas G. Torr Feb. 1991 343 p
(Contract NAS8-37586)
(NASA-CR-184138; NAS 1.26:184138) Avail: NTIS HC/MF A15 CSCL 22B

Design and development activities were carried out for the Ultraviolet Imager (UVI) to be flown on the Polar Spacecraft of the INternational Solar Terrestrial Physics (ISTP) Mission. The following tasks were performed: (1) design and fabrication of prototype/engineering model of the UVI imager; (2) preliminary design review; (3) vacuum ultraviolet filter design; (4) auroral energy deposition code; (5) model of LBH vehicle glow; (6) laboratory measurement program of collision cross-sections; and (7) support of ISTP meetings. Author

N91-22365*# Stanford Univ., CA.
THE ULTRA HIGH RESOLUTION XUV SPECTROHELIOGRAPH: AN ATTACHED PAYLOAD FOR THE SPACE STATION FREEDOM Final Report
Arthur B. C. Walker, Jr., Richard B. Hoover, Troy W. Barbee, Jr., Einar Tandberg-Hanssen (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.), J. Gethyn Timothy, and Joakim F. Lindblom Oct. 1990 61 p
(Contract NAS8-38666)
(NASA-CR-184156; NAS 1.26:184156; UHRXS-90-2) Avail: NTIS HC/MF A04 CSCL 22B

The principle goal of the ultra high resolution XUV spectroheliograph (UHRXS) is to improve the ability to identify and understand the fundamental physical processes that shape the structure and dynamics of the solar chromosphere and corona. The ability of the UHRXS imaging telescope and spectrographs to resolve fine scale structures over a broad wavelength (and hence temperature) range is critical to this mission. The scientific objectives and instrumental capabilities of the UHRXS investigation are reviewed before proceeding to a discussion of the expected performance of the UHRXS observatory. Author

20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxilliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

N91-22366*# Martin Marietta Aerospace, New Orleans, LA. Manned Space Systems.
LIQUID ROCKET BOOSTER (LRB) FOR THE SPACE TRANSPORTATION SYSTEM (STS) SYSTEMS STUDY. VOLUME 2: ADDENDUM 1 Final Report
Feb. 1990 100 p
(Contract NAS8-37136)
(NASA-CR-184128; NAS 1.26:184128) Avail: NTIS HC/MF A05 CSCL 21H

The potential of a common Liquid Rocket Booster (LRB) design was evaluated for use with both the Space Transportation System (STS) and the Advanced Launch System (ALS). A goal is to have a common Liquid Oxygen/Liquid Hydrogen (LO2/LH2) engine developed for both the ALS booster and the core stage. The LO2/LH2 option for the STS was evaluated to identify potential LRB program cost reductions. The objective was to identify the structural impacts to the external tank (ET), and to determine if any significant ET re-development costs are required as a result of the larger LO2/LH2 LRB. The potential ET impacts evaluated are presented. Author

N91-22367*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EVALUATION OF THERMAL CONTROL COATINGS FOR USE ON SOLAR DYNAMIC RADIATORS IN LOW EARTH ORBIT
Joyce A. Dever, Elvin Rodriguez, Wayne S. Slemp, and Joseph E. Stoyack (LTV Missiles and Electronics Group, Grand Prairie, TX.) 1991 13 p Proposed for presentation at the 26th Thermophysics Conference, Honolulu, HI, 24-26 Jun. 1991; sponsored by AIAA
(NASA-TM-104335; E-6103; NAS 1.15:104335; AIAA-91-1327)
Avail: NTIS HC/MF A03 CSCL 10B

Thermal control coatings with high thermal emittance and low solar absorptance are needed for Space Station Freedom (SSF) solar dynamic power module radiator (SDR) surfaces for efficient heat rejection. Additionally, these coatings must be durable to low earth orbital (LEO) environmental effects of atomic oxygen, ultraviolet radiation and deep thermal cycles which occur as a result of start-up and shut-down of the solar dynamic power system. Eleven candidate coatings were characterized for their solar absorptance and emittance before and after exposure to ultraviolet (UV) radiation (200 to 400 nm), vacuum UV (VUV) radiation (100 to 200 nm) and atomic oxygen. Results indicated that the most durable and best performing coatings were white paint thermal control coatings Z-93, zinc oxide pigment in potassium silicate binder, and YB-71, zinc orthotitanate pigment in potassium silicate binder. Optical micrographs of these materials exposed to the individual environmental effects of atomic oxygen and vacuum thermal cycling showed that no surface cracking occurred.
Author

N91-22368*# General Dynamics Corp., Huntsville, AL.
LIQUID ROCKET BOOSTER STUDY ADDENDUM Final Report
31 Aug. 1990 59 p
(Contract NAS8-37137)
(NASA-CR-184127; NAS 1.26:184127; Rept-90-9550-9) Avail: NTIS HC/MF A04 CSCL 21H

Liquid rocket booster study (LRB) addendum to final report is presented in the form of the view-graphs. The following subject areas are covered: LRB launch vehicle concepts; LRB design; propulsion system configurations; LRB boattail for Shuttle-C application; and manned transportation systems. Author

N91-22369# Aerospace Corp., El Segundo, CA. Lab. Operations.
ULTRASONIC EVALUATION OF SRMU BONDLINES
Eric C. Johnson, Juliet N. Schurr, and Gary F. Hawkins 4 Jan. 1991 22 p
(Contract F04701-88-C-0089)
(AD-A231697; TR-0089(4530-04)-2; SSD-TR-90-54) Avail: NTIS HC/MF A03 CSCL 21/9

Pulse Echo (PE) ultrasonic evaluation of a solid rocket motor upgrade (SRMU) test sample was performed in our laboratory. The test sample contained simulated delaminations between both the Gr/Ep composite/insulator bondline and the insulator/inert propellant bondline. In this report, the acoustic properties of the SMRU component materials are used to construct a theoretical model for ultrasonic pulse propagation within the sample. The experimental results are then compared with the predictions from this model. This evaluation showed that PE ultrasonic inspection of the SRMU bondlines is feasible. In addition, several means for improving one's capability to detect disbonded regions are suggested. GRA

N91-22370*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FINDINGS OF THE JOINT WORKSHOP ON EVALUATION OF IMPACTS OF SPACE STATION FREEDOM GROUND CONFIGURATIONS
Dale C. Ferguson, David B. Snyder, and Ralph Carruth (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.) 1990 9 p Presented at the Space Environment Analysis Workshop, Noordwijk, Netherlands, 9-12 Oct. 1990; sponsored by ESA
(NASA-TM-103717; E-5950; NAS 1.15:103717) Avail: NTIS HC/MF A02 CSCL 22B

A workshop to consider the effects of various proposed Space Station Freedom (SSF) grounding schemes was held. Expert from the plasma interactions community evaluated the impacts of environmental interactions on SSF under each of three proposed grounding schemes. The choice of the grounding scheme for the SSF power system was found to have important implications for SSF design. Interactions of the SSF power system and structure with the low earth orbit (LEO) plasma differ significantly between different grounding schemes. Environmental constraints will require modification of current SSF designs under any grounding scheme. Maintaining the present negative ground scheme may compromise SSF safety, structural integrity, and electromagnetic compatibility, and will increase contamination rates over alternate schemes. Positive grounding of the array requires redesign of the primary power system. Floating the array reduces the number of circuit changes in the primary power system but adds new hardware. Maintaining the present design will affect all parts of SSF. However, no impacts were identified on SSF systems outside of the electrical power system by positively grounding or floating the array.
Author

N91-22371*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FUTURE MISSION OPPORTUNITIES AND REQUIREMENTS FOR ADVANCED SPACE PHOTOVOLTAIC ENERGY CONVERSION TECHNOLOGY
Dennis J. Flood 1990 12 p Presented at the 5th International Photovoltaic Science and Engineering Conference, Kyoto, Japan, 26-30 Nov. 1990; sponsored in part by The Japan Society of Applied Physics, The Inst. of Electrical Engineers of Japan, and Foundation for the Advanceme
(NASA-TM-103661; E-5857; NAS 1.15:103661) Avail: NTIS HC/MF A03 CSCL 10A

The variety of potential future missions under consideration by NASA will impose a broad range of requirements on space solar arrays, and mandates the development of new solar cells which can offer a wide range of capabilities to mission planners. Major advances in performance have recently been achieved at several laboratories in a variety of solar cell types. Many of those recent advances are reviewed, the areas are examined where possible improvements are yet to be made, and the requirements are discussed that must be met by advanced solar cell if they are to be used in space. The solar cells of interest include single and multiple junction cells which are fabricated from single crystal, polycrystalline and amorphous materials. Single crystal cells on foreign substrates, thin film single crystal cells on superstrates, and multiple junction cells which are either mechanically stacked, monolithically grown, or hybrid structures incorporating both techniques are discussed. Advanced concentrator array technology for space applications is described, and the status of thin film, flexible solar array blanket technology is reported. Author

N91-22372*# Microfab Technologies, Inc., Plano, TX.
STUDY OF ORIFICE FABRICATION TECHNOLOGIES FOR THE LIQUID DROPLET RADIATOR Final Report
David B. Wallace, Donald J. Hayes, and J. Michael Bush May 1991 55 p
(Contract NAS3-25275)
(NASA-CR-187114; NAS 1.26:187114) Avail: NTIS HC/MF A04 CSCL 20D

Eleven orifice fabrication technologies potentially applicable for a liquid droplet radiator are discussed. The evaluation is focused on technologies capable of yielding 25-150 microns diameter orifices with trajectory accuracies below 5 milliradians, ultimately in arrays of up to 4000 orifices. An initial analytical screening considering factors such as trajectory accuracy, manufacturability, and hydrodynamics of orifice flow is presented. Based on this screening, four technologies were selected for experimental evaluation. A jet straightness system used to test 50-orifice arrays made by electro-discharge machining (EDM), Fotoceram, and mechanical drilling is discussed. Measurements on orifice diameter control and jet trajectory accuracy are presented and discussed. Trajectory standard deviations are in the 4.6-10.0 milliradian range. Electroforming and EDM appear to have the greatest potential for Liquid Droplet Radiator applications. The direction of a future development effort is discussed. Author

N91-22373*# Aerojet Technical Systems Co., Sacramento, CA. Propulsion Div.
ENGINE THROAT/NOZZLE OPTICS FOR PLUME SPECTROSCOPY Final Report, 23 Mar. 1190 - 23 Jan. 1991
R. L. Bickford and D. B. Duncan 1 Feb. 1991 89 p
(Contract NAS3-25883)
(NASA-CR-188118; NAS 1.26:188118) Avail: NTIS HC/MF A05 CSCL 21H

The Task 2.0 Engine Throat/Nozzle Optics for Pume Spectroscopy, effort was performed undet the NASA LeRC Development of Life Prediction Capabilities for Liquid Propellant Rocket Engines program. This Task produced the engineering design of an optical probe to enable spectroscopic measurements within the SSME main chamber. The probe mounts on the SSME nozzle aft manifold and collects light emitted from the throat plane and chamber. Light collected by the probe is transferred to a spectrometer through a fiber optic cable. The design analyses indicate that the probe will function throughout the engine operating cycle and is suitable for both test stand and flight operations. By detecting metallic emissions that are indicative of component degradation or incipient failure, engine shutdown can be initiated before catastrophic failure. This capability will protect valuable test stand hardware and provide enhanced mission safety. GRA

N91-22374*# Martin Marietta Corp., New Orleans, LA.
LIQUID ROCKET BOOSTER (LRB) FOR THE SPACE TRANSPORTATION SYSTEM (STS) SYSTEMS STUDY, VOLUME 2, ADDENDUM 2 Final Report
Mar. 1991 61 p
(Contract NAS8-37136)
(NASA-CR-184155; NAS 1.26:184155) Avail: NTIS HC/MF A04 CSCL 21H

The feasibility of developing and producing a launch vehicle from an external tank (ET) and an engine module that mounts inline to the tankage at the aft end and contains six space transportation main engines (STME), was assessed. The primary

mission of this launch vehicle would be to place a PLS (personnel launch vehicle) into a low earth orbit (LEO). The vehicle tankage and the assembly of the engine module, was evaluated to determine what, if any, manufacturing/production impacts would be incurred if this vehicle were built along side the current ET at Michoud Assembly Facility. It was determined that there would be no significant impacts to produce seven of these vehicles per year while concurrently producing 12 ETs per year. Preliminary estimates of both nonrecurring and recurring costs for this vehicle concept were made. B.G.

N91-22375*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EFFECT OF LEO CYCLING ON 125 Ah ADVANCED DESIGN IPV NICKEL-HYDROGEN FLIGHT CELLS. AN UPDATE
John J. Smithrick and Stephen W. Hall (Naval Weapons Support Center, Crane, IN.) 1991 9 p Presented at the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, 4-9 Aug. 1991; sponsored by ANS, SAE, American Chemical Society, AIAA, ASME, IEEE, and American Inst. of Chemical Engineers
(NASA-TM-104384; E-6193; NAS 1.15:104384) Avail: NTIS HC/MF A02 CSCL 21H

Validation testing of the NASA Lewis 125 Ah advanced design individual pressure vessel (IPV) nickel-hydrogen flight cells was conducted. Work consisted of characterization, storage, and cycle life testing. There was no capacity degradation after 52 days of storage with the cells in the discharged state, an open circuit, 0 C, and a hydrogen pressure of 14.5 psia. The catalyzed wall wick cells were cycled for over 11,000 cycles with no cell failures in the continuing test. One of the noncatalyzed wall wick cells failed. Author

N91-22376*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EFFECT OF KOH CONCENTRATION ON LEO CYCLE LIFE OF IPV NICKEL-HYDROGEN FLIGHT CELLS. AN UPDATE
John J. Smithrick and Stephen W. Hall (Naval Weapons Support Center, Crane, IN.) 1991 8 p Presented at the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, 4-9 Aug. 1991: sponsored by ANS, SAE, American Chemical Society, AIAA, ASME, IEEE, and American Inst. of Chemical Engineers
(NASA-TM-104383; E-6192; NAS 1.15:104383) Avail: NTIS HC/MF A02 CSCL 10B

An update of validation test results confirming the breakthrough in LEO cycle life of nickel-hydrogen cells containing 26 percent potassium hydroxide (KOH) electrolyte is presented. A breakthrough in the LEO cycle life of individual pressure vessel nickel-hydrogen cells is reported. The cycle life of boiler plate cells containing 26 percent KOH electrolyte was about 40,000 LEO cycles compared to 3500 cycles for cells containing 31 percent KOH. Author

N91-22140*# Forward Unltd., Malibu, CA.
EXOTIC POWER AND PROPULSION CONCEPTS
Robert L. Forward *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 11-36 (For primary document see N91-22139 14-12)
(Contract F04611-87-C-0029)
Avail: NTIS HC/MF A25 CSCL 21H

N91-22145*# Brookhaven National Lab., Upton, NY.
THE LIQUID ANNULAR REACTOR SYSTEM (LARS) PROPULSION
James Powell, Hans Ludewig, Frederick Horn, and Roger Lenard (Strategic Defense Initiative Organization, Washington, DC.) *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 114-123 (For primary document see N91-22139 14-12)
(Contract DE-AC02-76CH-00016)
Avail: NTIS HC/MF A25 CSCL 21H

N91-22146*# Martin Marietta Aerospace, Denver, CO.
NUCLEAR THERMAL ROCKETS USING INDIGENOUS EXTRATERRESTRIAL PROPELLANTS
Robert M. Zubrin *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 124-140 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

N91-22147*# Illinois Univ., Urbana. Dept. of Nuclear Engineering.
AN APPROACH TO SPACE POWER
G. H. Miley, J. H. Nadler, T. Hochberg, O. Barnouin, and Y. B. Gu *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 141-149 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

N91-22148*# National Aeronautics and Space Administration, Washington, DC.
THE NASA-LEWIS PROGRAM ON FUSION ENERGY FOR SPACE POWER AND PROPULSION, 1958-1978
Norman R. Schulze and J. Reece Roth (Tennessee Univ., Knoxville.) *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 150-156 Submitted for publication (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

N91-22149*# Tennessee Univ., Knoxville. Dept. of Electrical and Computer Engineering.
SAFETY AND ENVIRONMENTAL CONSTRAINTS ON SPACE APPLICATIONS OF FUSION ENERGY
J. Reece Roth *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 157-169 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

N91-22151*# General Atomic Co., San Diego, CA.
PULSED PLASMOID ELECTRIC PROPULSION
Robert F. Bourque, Paul B. Parks, and Teruo Tamano *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 179-192 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

N91-22155*# McDonnell-Douglas Space Systems Co., Huntington Beach, CA.
THE 21ST CENTURY PROPULSION
V. E. Haloulakos and C. Boehmer *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 228-251 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

N91-22161*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EXPLORING THE NOTION OF SPACE COUPLING PROPULSION
Marc G. Millis *In its* Vision-21: Space Travel for the Next Millennium Apr. 1990 p 307-316 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

N91-22163*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
REACTIONLESS PROPULSION USING TETHERS
Geoffrey A. Landis *In its* Vision-21: Space Travel for the Next Millennium Apr. 1990 p 330-340 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

N91-22176*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE THEORY OF AN AUTO-RESONANT FIELD EMISSION CATHODE RELATIVISTIC ELECTRON ACCELERATOR FOR HIGH EFFICIENCY MICROWAVE TO DIRECT CURRENT POWER CONVERSION
Robert M. Manning *In its* Vision-21: Space Travel for the Next

Millennium Apr. 1990 p 468-476 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21H

23 CHEMISTRY AND MATERIALS (GENERAL)

N91-22377*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
VISCOELASTIC PROPERTIES OF ADDITION-CURED POLYIMIDES USED IN HIGH TEMPERATURE POLYMER MATRIX COMPOSITES
Gary D Roberts,, Diane C. Malarik, and Jerrold O. Robaidek (Case Western Reserve Univ., Cleveland, OH.) 1991 11 p Proposed for presentation at the 8th International Conference on Composite Materials, Honolulu, HI, 15-19 Jul. 1991; cosponsored by Society for the Advancement of Material and Process Engineering, American Society of Composites, American Inst. of
(NASA-TM-103768; E-6001; NAS 1.15:103768) Avail: NTIS HC/MF A03 CSCL 11D

Viscoelastic properties of the addition cured polyimide, PMR-15, were studied using dynamic mechanical and stress relaxation tests. For temperatures below the glass transition temperature, T sub g, the dynamic mechanical properties measured using a temperature scan rate of 10 C/min were strongly affected by the presence of absorbed moisture in the resin. Dynamic mechanical properties measured as a function of time during an isothermal hold provided an indication of chemical changes occurring in the resin. For temperatures above (T sub g + 20 C), the storage modulus increased continuously as a function of time indicating that additional crosslinking is occurring in the resin. Because of these changes in chemical structures, the stress relaxation modulus could not be measured over any useful time interval for temperatures above T sub g. For temperatures below T sub g, dynamic mechanical properties appeared to be unaffected by chemical changes for times exceeding 1 hr. Since the duration of the stress relaxation tests was less than 1 hr, the stress relaxation modulus could be measured. As long as the moisture content of the resin was less than 2 pct, stress relaxation curves measured at different temperatures could be superimposed using horizontal shifts along the log(time) axis with only small shifts along the vertical axis.
Author

N91-22378# National Critical Technologies Panel, Arlington, VA.
REPORT OF THE NATIONAL CRITICAL TECHNOLOGIES PANEL
Mar. 1991 109 p
(PB91-156869) Avail: NTIS HC/MF A06; also available SOD HC $9.50 as 040-000-00-557-9

Twenty-two technologies deemed critical to the national economic prosperity and to national security have been identified. The selection of national critical technologies was carried out by a panel appointed by the Director, Office of Science and Technology Policy, Executive Office of the President. The study was authorized by the Fiscal Year 1990 Defense Authorization Act and will be updated biennially through the year 2000. This panel report discusses each technology separately with respect to scope, basis fof selection, and international trends. The technologies fall into six broad areas: materials, manufacturing, information and communications, biotechnology and life sciences, aeronautics and surface transportation, and energy and environment. A major conclusion of the study is that technology alone cannot ensure economic prosperity and national security. Technology can make an important contribution to the future of U.S. national interests, but only if we learn to use it more effectively.
Author

N91-22379*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TRIBOLOGICAL CHARACTERISTICS OF SILICON CARBIDE WHISKER-REINFORCED ALUMINA AT ELEVATED TEMPERATURES
Christopher DellaCorte Apr. 1991 45 p Submitted for publication
(NASA-TM-103799; E-5990; NAS 1.15:103799) Avail: NTIS HC/MF A03 CSCL 07A

The enhanced fracture toughness of whisker reinforced ceramics makes them attractive candidates for sliding components of advanced hear engines. Examples include piston rings and valve stems for Stirling engines and other low heat rejection devices. However, the tribological behavior of whisker reinforced ceramics is largely unknown. This is especially true for the applications described where use temperatures can vary from below ambient to well over 1000 C. An experimental research program to identify the dominant wear mechanism(s) for a silicon carbide whisker reinforced alumina composite, SiCw-Al2O3 is described. In addition, a wear mechanism model is developed to explain and corroborate the experimental results and to provide insight for material improvement.
Author

24 COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.
For ceramic materials see *27 Nonmetallic Materials.*

N91-22380# Tokyo Univ. (Japan).
PROCEEDINGS OF A FRENCH-JAPANESE SEMINAR ON COMPOSITE MATERIALS: PROCESSING, USE AND DATABASES
1990 126 p Seminar held in Paris, France, 13-14 Mar. 1990 Prepared in cooperation with Aerospatiale, Suresnes (France)
Avail: NTIS HC/MF A07

Topics addressed include: new composite materials; processing and fabrication; data bases; reinforcing fibers; metal matrix composites; fatigue tests; creep properties; and evaluation and fabrication.
B.G.

N91-22381 Cranfield Inst. of Tech., Bedford (England).
DAMAGE ACCUMULATION AND DEGRADATION OF COMPOSITE LAMINATES UNDER AIRCRAFT SERVICE LOADING: ASSESSMENT AND PREDICTION, VOLUMES 1 AND 2 Ph.D. Thesis
I. R. Farrow 1989 387 p
Avail: Univ. Microfilms Order BRDX90938

Methods were investigated for load idealization and damage accumulation modeling for life and residual strength prediction of advanced composite materials. A comprehensive test program was performed including static strength and fatigue of continuous carbon fiber epoxy composite specimens. Test control and monitoring systems were developed and the importance of error and frequency optimization and transducer monitoring of composite laminate materials were monitored. Load and displacement data acquisition has provided invaluable information in terms of modulus and creep parameters to illustrate the damage accumulation trends and effective failure states. Three phase damage accumulations, described by wear-in, stable, and wear-out phases of modulus reduction were recorded, statistically processed, and used in subsequent analysis. Spectrum fatigue tests have shown that the high load truncation level should be taken to the once per life design limit level and low load omission should be restricted to cycles with low mean stresses. Two-level programmed block tests have shown a pronounced load sequence effect. Assumptions of available standardized load spectra and the concept of statistical counting were reviewed. Classical and contemporary damage accumulation models were also reviewed. Linear and nonlinear damage accumulation models were developed, based on a modulus reduction damage parameter. The models were applied to predict the fatigue lives of variable amplitude tests performed. Damage

accumulation models based on nondestructive measurements are recommended for their potential of damage tolerant support from in-service measurements. An estimation of minimum expected residual strength for a given level of damage parameter was proposed. The development of a nonlinear 'Interactive Parameter Cumulative Damage' model was considered as a fundamental attempt to exploit constant amplitude fatigue data for the prediction of variable amplitude fatigue of advanced composites.
Dissert. Abstr.

N91-22382 Arizona State Univ., Tempe.
HIGH-TEMPERATURE CREEP BEHAVIOR OF SECOND-PHASE PARTICLE-STRENGTHENED TUNGSTEN-RHENIUM ALLOYS Ph.D. Thesis
Bor-Liang Chen 1990 198 p
Avail: Univ. Microfilms Order No. DA9101862

The creep behavior of W-4Re-0.26HfC, W-3.6Re-1ThO2, W-11Re-1ThO2, and W-26Re-1ThO2 alloys were evaluated at elevated temperatures (between 1955 and 2500 K) in a custom-built high vacuum creep testing facility. These alloys are promising emitter materials for the Thermionic Energy Converter. The effects of stress and temperature on the creep rate of these alloys were determined and the stress exponents and creep activation energies of these alloys were measured. Results showed that HfC particles have a very high strengthening effect on the W-4Re matrix up to 2200 K. At temperatures higher than 2200 K the coarsening rate of HfC is so high that they lose their strengthening effect rapidly. Comparing the creep strength of the arc-melted W-4Re-0.26HfC with that of the P/M W-Re-1ThO2 alloys, it was found that at temperatures less than or equal to 2200 K, W-4Re-0.26HfC has the highest creep. Dissert. Abstr.

N91-22383 Delaware Univ., Newark.
INTERFACE CHARACTERIZATION OF CARBON/ALUMINUM COMPOSITES Ph.D. Thesis
Ashish P. Diwanji 1990 155 p
Avail: Univ. Microfilms Order No. DA9101065

A detailed processing-microstructure-mechanical property characterization of unidirectionally reinforced C/Al composites was performed. A systematic variation of 24 squeeze casting parameters (such as fiber type, surface treatment, matrix alloys, heat treatments, melt pour and preform temperatures, fiber volume fraction, and binders) was carried out to analyze their effects on the interface. Optical microscopy, electron microscopy/diffraction, and XPS/EDS were used to observe and characterize the microstructure of the interface. Each type of composite was tested in longitudinal tension and Mode II shear. Dissert. Abstr.

N91-22384*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ANALYSIS OF MATRIX CRACKING AND LOCAL DELAMINATION IN (0/THETA/-THETA)SUB s GRAPHITE EPOXY LAMINATES UNDER TENSION LOAD
S. A. Salpekar (Analytical Services and Materials, Inc., Hampton, VA.) and T. K. OBrien Mar. 1991 29 p Prepared in cooperation with Army Aviation Systems Command, Hampton, VA
(NASA-TM-104062; NAS 1.15:104062; AVSCOM-TR-91-B-002)
Avail: NTIS HC/MF A03 CSCL 11D

Several 3D finite element analyses of (0/theta/-theta)sub s graphite epoxy laminates, where theta=15, 20, 25, 30, and 45 deg, subjected to axial tension load were performed. The interlaminar stresses in the theta/-theta interface were calculated with and without a matrix crack in the central -theta plies. The interlaminar normal stress changes from a small compressive stress when no matrix crack is present to a high tensile stress at the intersection of the matrix crack and free edge. The analysis of local delamination from the -theta matrix crack indicates a high strain energy release rate and a localized mode I component near the free edge, within one ply distance from the matrix crack. In order to examine the stress state causing the matrix cracking the maximum principal normal stress in a plane perpendicular to the fiber direction in the -theta ply was calculated in an uncracked laminate. The corresponding shear stress parallel to the fiber was also calculated. The principal normal stress at the laminate edge increases through the ply thickness and reached a very high tensile value at the theta/-theta interface indicating that the crack in the -theta ply may initiate at the theta/-theta interface. Crack profiles on the laminate edge in the -theta ply were constructed from the principal stress directions. The cracks were found to be more curved for layups with smaller theta angles, which is consistent with experimental observations in the literature. Author

N91-22385# Army Lab. Command, Watertown, MA. Material Technology Lab.
A COMPUTATIONALLY VIABLE HIGHER-ORDER THEORY FOR LAMINATED COMPOSITE PLATES Final Report
Alexander Tessler and Erik Saether Nov. 1990 35 p
(AD-A231423; MTL-TR-90-59) Avail: NTIS HC/MF A03 CSCL 11/4

A variational higher-order theory involving all transverse strain and stress components is proposed for the analysis of laminated composites plates. Derived from three-dimensional elasticity with emphasis on developing a viable computational methodology, the theory is well studied for finite element approximations as it incorporates both C(sup 0) and C(sup -1) continuous kinematic fields and Poisson boundary conditions. From the theory, a simple three-node stretching-bending finite element is developed and applied to the problem of cylindrical bending of a symmetric carbon/epoxy laminate for which an exact solution is available. Both the analytic and finite element result were found to be in excellent agreement with the exact solution for a wide range of the length-to-thickness ratio. The proposed higher-order theory has the same computational advantages as first-order shear-deformable theories. The present methodology, however, provides greater predictive capability, especially, for thick-section composites.
GRA

N91-22386# Army Lab. Command, Fort Monmouth, NJ. Electronics Technology and Devices Lab.
NUMERICAL ANALYSIS OF COMPOSITE DIELECTRICS: PRELIMINARY RESULTS FOR TWO DIMENSIONS Technical Report, May - Aug. 1990
Stephen Wallin, John Kosinski, and Arthur Ballato Sep. 1990 59 p
(AD-A231519; SLCET-TR-90-11) Avail: NTIS HC/MF A04 CSCL 20/3

The use of composite materials and structures to provide characteristics unattainable directly from the constituent materials is well known. Recently, work has been undertaken to apply this principle to development of dielectric materials for energy storage applications. It is anticipated that this technology will provide materials for use in capacitors with greater energy density, lower loss, and higher breakdown resistance. This report describes the results of an effort to analytically model the net or resultant dielectric behavior of such composite dielectric materials. A theoretical model of the composite dielectric is presented and a computer code implementing the model is discussed along with preliminary results for the two-dimensional case. GRA

N91-22387# Chemical Research and Development Center, Aberdeen Proving Ground, MD.
SPECTROSCOPIC ANALYSES AND PERFORMANCE OF COPPER/ZINC IMPREGNATED, ACTIVATED CARBONS Final Report, Aug. 1989 - Aug. 1990
Erica Peterson, Robert Morrison, Michelle Farris, and Joseph Rossin (Geo-Centers, Inc., Fort Washington, MD.) Dec. 1990 33 p Prepared incooperation with Geo-Centers, Inc., Fort Washington, MD
(DA Proj. 1C1-62622-A-553-E)
(AD-A231693; CRDEC-TR-251) Avail: NTIS HC/MF A03 CSCL 11/6

The U.S. Army Chemical Research, Development and Engineering Center is presently developing chromium-free carbons for collective and individual air purification systems. Spectroscopic analyses were performed on similar copper/zinc impregnated carbon samples prepared from a laboratory and production scale

process. These samples displayed different levels of hydrogen cyanide protection. The difference in the performance was attributed to the location of copper within the carbon granules. In addition, copper was found to leach from the carbon granule during prolonged humid exposure. The leaching of copper resulted in a decrease in the level of hydrogen cyanide protection, as evidenced by premature breakthrough of a reaction product, cyanogen.
GRA

N91-22388# Martin Marietta Aerospace, Denver, CO.
FABRICATION OF INTERMETALLIC COMPOUNDS BY SOLID STATE REACTION OF ROLL-BONDED MATERIALS Quarterly Report, No. 18, 10 Nov. - 9 Feb. 1990
W. C. Moshier 9 Feb. 1990 8 p
(Contract N00014-85-C-0857)
(AD-A231720; MCR-85-721) Avail: NTIS HC/MF A02 CSCL 11/6

Intermetallic compounds offer very high specific material properties and property retention at elevated temperatures. However reliable processing techniques to fabricate these materials have not been developed. This program will investigate the use of a novel, low cost fabrication technique involving a deformation-solid state reaction bonding process to form titanium beryllides. Transmission electron microscopy of the sputtered foils was initiated during the previous period. Analysis of an as-deposited foil containing approximately 93 percent Be showed that the grain size of the material was approximately 200 to 300 nm, the interior of grains contained a high defect concentration, and the structure was TiBe12, as indicated by selected area diffraction. Heat treatment studies were also initiated to determine the optimum annealing conditions for the foils. GRA

N91-22389# National Inst. of Standards and Technology, Gaithersburg, MD. Metallurgy Div.
THE INFLUENCE OF WATER ON THE MECHANICAL PROPERTIES OF A GLASS-EPOXY MATRIX COMPOSITE Technical Report, 1 Feb. 1989 - 1 Feb. 1991
M. R. Stoudt, E. Escalante, and R. E. Ricker 12 Feb. 1991 14 p
(Contract N00014-89-F-0072)
(AD-A231778) Avail: NTIS HC/MF A03 CSCL 11/4

The influence of exposure to water at ambient pressure and at an elevated pressure on the mechanical properties of a glass fiber epoxy matrix composite was investigated. The mechanical properties of three orientations of the composite were determined in the dry condition, after exposure to water at ambient pressure and after exposure to water at 5.9 MPa. Then, to determine the mechanism of the observed degradation, the mechanical properties of samples exposed at the two pressures were determined after the absorbed water was removed. The rate and extent of water absorption and desorption was evaluated by measuring the weight change at periodic intervals. GRA

N91-22390# Cornell Univ., Ithaca, NY. Dept. of Materials Science and Engineering.
BONDING AT METAL-CERAMIC INTERFACES IN HYBRID MATERIALS Final Technical Report, 1 Sep. 1986 - 31 Mar. 1990
Rishi Raj 31 Dec. 1990 89 p
(Grant AF-AFOSR-0321-86; AF Proj. 2306)
(AD-A231883; AFOSR-91-0036TR) Avail: NTIS HC/MF A05 CSCL 11/2

Mechanical properties of metal-ceramic interfaces were measured at high temperatures. New methods were developed to measure the time and strain rate dependent properties of metal-ceramic interfaces under shear loading and under tensile loading. The shear experiment consisted of depositing a film of the ceramic on the metal and stretching the metal until periodic cracks developed in the ceramic film. Experiments on the copper/silica system demonstrated that these interfaces slide at high temperatures, with a linear relationship between sliding rate and the interfacial shear stress. In tensile experiments, bicrystals of copper and sapphire were loaded in tension. GRA

N91-22391# Implant Sciences Corp., Danvers, MA.
BURIED SILICIDE INTERCONNECTIONS WITH BONDED WAFERS Final Report, 15 May 1990 - 15 Feb. 1991
S. N. Bunker 15 Feb. 1991 17 p
(Contract DASG60-90-C-0037)
(AD-A231884) Avail: NTIS HC/MF A03 CSCL 09/1

Complex monolithic integrated circuits are increasingly limited by the needs of device interconnections. Existing materials take up valuable real estate on the die, limit current and are subject to parasitic capacitances. The use of multilevel and 3D structures has been suggested in order to avoid some of these problems. Formation of conductors by ion implantation shows promise for providing such connections if certain practical problems can be overcome. Novel implementation techniques are proposed which would demonstrate the practicality of complex interconnection patterns. GRA

N91-22392# Army Armament Research, Development and Engineering Center, Watervliet, NY. Weapons Lab.
EFFECTS OF NOTCH GEOMETRY AND MOISTURE ON FRACTURE STRENGTH OF CARBON/EPOXY AND CARBON/BISMALEIMIDE LAMINATES Final Report
J. H. Underwood, I. A. Burch, and S. Bandyopadhyay Dec. 1990 45 p
(AD-A231892; ARCCB-TR-90035) Avail: NTIS HC/MF A03 CSCL 11/4

Cross-ply panels of various ply orientations and 1 to 2-mm thickness were tested in tension with a center notch to determine the translaminar fracture toughness and in bending with no notch to determine the bulk flexural strength and modulus. Carbon/epoxy panels with a variety of notch lengths and widths were subjected to laboratory air conditions before testing. Carbon/bismaleimide panels with one basic notch configuration were tested in three pretest exposure conditions: laboratory air; a 4000-hour exposure in a controlled moisture chamber; and a 4000-hour exposure in a natural tropical environment. GRA

N91-22393# Army Lab. Command, Watertown, MA. Material Technology Lab.
PILOT PREPREG LINE: A COMPREHENSIVE ANALYSIS OF PREPREG QUALITY Final Report
Seth R. Ghiorse, Walter X. Zukas, and Gary E. Foley Oct. 1990 28 p
(AD-A231912; MTL-TR-90-48) Avail: NTIS HC/MF A03 CSCL 11/4

A pilot prepreg line was used to produce an S2 glass epoxy/anhydride prepreg. It was found that the pilot line produced high quality unidirectional glass epoxy tape. The prepreg was evaluated from three standpoints; processing, chemistry, and material properties. Both fiber- and matrix-dominated material properties compared favorably with structural S2 glass epoxy laminate data found in published literature. The prepreg line metering and mixing system yielded a consistently well mixed and metered resin. Close attention to collimation of the fiber tows was found to be essential to maintaining tape quality. The prepreg was B-staged at room temperature and this reaction was found to be governed by first order kinetics. The service temperature of the cured laminate was typically found to be about 100 C, but was highly sensitive to the presence of moisture in the B-staging environment. GRA

N91-22394# Cornell Univ., Ithaca, NY. Dept. of Materials Science and Engineering.
WORKSHOP ON HIGH TEMPERATURE METAL-CERAMIC COMPOSITES Final Technical Report, 1 May 1990 - 30 Apr. 1991
Rishi Raj 26 Dec. 1990 8 p Workshop held in Aurora, NY, 10-11 Sep. 1990
(Grant AF-AFOSR-0230-90; AF Proj. 2306)
(AD-A231945; AFOSR-91-0025TR) Avail: NTIS HC/MF A02 CSCL 11/4

The workshop on high temperature metal-ceramic interfaces was held in Aurora NY for two full days on Sep. 10 and 11, 1990.

Thirty five non-Cornell scientists, two of them from abroad, and ten Cornell scientists attended the workshop. They represented industry, universities and national laboratories. Five sessions were held with about equal time devoted to presentations and discussions. The subjects were measurement of the local mechanical properties of interfaces, constrained deformation, reactions at metal ceramic interfaces, new materials, and the atomic and electronic structure of metal-ceramic interfaces. The principal findings of the workshop were as follows: (1) scientific and fundamental guidelines are needed for the design of metal-ceramic composites, (2) much greater emphasis needs to be placed on the study of high temperature properties of such composites.
GRA

N91-22395# Stanford Univ., CA. Dept. of Aeronautics and Astronautics.
EFFECT OF TRANSVERSELY LOW-VELOCITY IMPACT ON GRAPHITE/EPOXY LAMINATED COMPOSITES Final Report, 1 Oct. 1987 - 30 Sep. 1990
Hyung-Yun Choi and Fu-Kuo Chang 30 Sep. 1990 186 p
(Contract DAAL03-87-K-0115)
(AD-A231964; ARO-24538.5-EG) Avail: NTIS HC/MF A09
CSCL 11/4

An investigation was performed to study the damage in Graphite/Epoxy laminated composites resulting from transversely low-velocity impact. Matrix cracking and delaminations were the primary concern of the study. This research was divided into two sequential steps: (1) characterization of impact damage, and (2) development of an analytical model for estimating impact damage in composites. A unique impact tester was developed for the study. The major characteristic of the tester is the design of a rectangular barrel so that the impactor can be designed in two parts: a nose and a base. Accordingly, different types of impact damage can be produced by appropriately selecting the nose shape of the impactor.
GRA

N91-22396*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SOLID LUBRICANTS
Harold E. Sliney Apr. 1991 37 p Submitted for publication
(NASA-TM-102803; E-6094; NAS 1.15:102803) Avail: NTIS HC/MF A03 CSCL 11D

The state of knowledge of solid lubricants is reviewed. The results of research on solid lubricants from the 1940's to the present are presented from a historical perspective. Emphasis is placed largely, but not exclusively, on work performed at NASA Lewis Research Center with a natural focus on aerospace applications. However, because of the generic nature of the research, the information presented in this review is applicable to most areas where solid lubricant technology is useful.
Author

N91-22397*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NONDIMENSIONAL PARAMETERS AND EQUATIONS FOR BUCKLING OF SYMMETRICALLY LAMINATED THIN ELASTIC SHALLOW SHELLS
Michael P. Nemeth Mar. 1991 47 p
(NASA-TM-104060; NAS 1.15:104060) Avail: NTIS HC/MF A03 CSCL 11D

A method of deriving nondimensional equations and identifying the fundamental parameters associated with bifurcation buckling of anisotropic shells subjected to combined loads is presented. The procedure and rationale used to obtain useful nondimensional forms of the transverse equilibrium and compatibility equations for buckling are presented. Fundamental parameters are identified that represent the importance of both membrane and bending orthotropy and anisotropy on the results.
Author

N91-22398# Bristol Univ. (England). Dept. of Aerospace Engineering.
YACHT MAST DESIGN: USING CARBON COMPOSITES B.S. Thesis
P. F. Johnstone and M. O. Preston Jun. 1990 54 p
(BU-507; ETN-91-99200) Avail: NTIS HC/MF A04

The performance of stainless steel fitting plates glued and/or bolted to the carbon fiber mast wall under loads of up to fifty kilonewtons was investigated. Parameters of the fitting that were altered included: adding additional +45/-45 degree layers to the basic mast sections; the inclusion of metal wafers into the last lay up; dispensing with redundant bolts and the backing plates in order to save weight. Objectives were achieved in that the manufacturers proof load of fifty kilonewtons was reached and in fact, the severity of the test program had to be increased because the composite specimens proved stronger than expected. Recommendations for the possible redesign of the fitting plate/mast wall arrangement were made. This would entail a desirable weight saving although it should be stressed that the consequences of shock loading could not be investigated in the time available. All specimens were cured on site and additionally the LUSAS finite element analysis package assisted in the analysis. In particular, the MYSTRO graphic package helped visualize the stress patterns present in the test specimens. The loading angle relative to the plates was 19 degrees although recommendations for varying this angle together with other ideas for future work were included.
ESA

N91-22399# Bristol Univ. (England). Dept. of Aerospace Engineering.
THE FLEXURAL STRENGTH OF UNIDIRECTIONAL CARBON FIBRE COMPOSITES B.S. Thesis
B. R. Lewis and V. W. Y. Shin Jun. 1990 103 p
(BU-509; ETN-91-99202) Avail: NTIS HC/MF A06

The objective was to study why, when the unidirectional carbon fiber composite specimens were subjected to bending, they failed on the tension side of the material rather than the compressive side. Tests were carried out on unidirectional carbon fiber reinforced plastics (CFRP) using a specifically designed combined compression and bending rig. An automatic data recording system was used in order to record strain and load data efficiently and accurately. This required the writing of a data logging computer program. Results and conclusions are given.
ESA

N91-22400# Bristol Univ. (England). Dept. of Aerospace Engineering.
MANUFACTURE TEST ANALYSIS OF THE THERMOPLASTIC COMPOSITES B.S. Thesis
S. C. Roe and D. Sadler Jun. 1990 197 p
(BU-515; ETN-91-99208) Avail: NTIS HC/MF A09

The validity of a cold press manufacture technique to produce thin plane thermoplastic composite laminates is examined. Verification of facilities to provide suitable quality assurance for panel inspection and test is considered. Consequences on panel form of mechanisms resulting in post forming residual stresses are established and discussed. It is demonstrated that the assumption of linearity in classical laminate theory necessarily yields non conservative strength predictions for quasi isotropic thin plane thermoplastic composite laminates.
ESA

N91-22401# Wichita State Univ., KS. National Inst. for Aviation Research.
THE EFFECT OF SPECIAL ORIENTATION ON THE FRACTURE BEHAVIOR OF GRAPHITE/EPOXY LAMINATES
J. Chaudhuri and Q. Jang Dec. 1990 13 p Previously announced in IAA as A89-30613
(NIAR-90-33) Avail: NTIS HC/MF A03

The improved fracture behavior of laminates with special configuration, as compared with the fracture behavior of balanced laminates is reported. The difference in fracture behavior of these laminates is believed to be due to the presence of in-plane negative Poisson's ratio in the laminates.
Author

N91-22402*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
IN-SITU X-RAY MONITORING OF DAMAGE ACCUMULATION IN SiC/RBSN TENSILE SPECIMENS

George Y. Baaklini and Ramakrishna T. Bhatt (Army Aviation Systems Command, Cleveland, OH.) 1991 19 p Presented at the 15th Annual Conference on Composites and Advanced Ceramics, Cocoa Beach, FL, 13-16 Jan. 1991; sponsored by the American Ceramic Society
(DA Proj. 1L1-62211-A-47-A)
(NASA-TM-103733; E-5971; NAS 1.15:103733;
AVSCOM-TR-90-C-019) Avail: NTIS HC/MF A03 CSCL 11D

The room-temperature tensile testing of silicon carbide fiber reinforced reaction-bonded silicon nitride (SiC/RBSN) composite specimens was monitored by using in-situ x ray film radiography. Radiographic evaluation before, during, and after loading provided data on the effect of preexisting volume flaws (high density impurities, and local density variations) on the fracture behavior of composites. Results from (0)1, (0)3, (0)5, and (0)8 composite specimens, showed that x ray film radiography can monitor damage accumulations during tensile loading. Matrix cracking, fiber-matrix debonding, and fiber pullout were imaged throughout the tensile loading history of the specimens. Further, in-situ film radiography was found to be a helpful and practical technique for estimating interfacial shear strength between the SiC fiber and the RBSN matrix by the matrix crack spacing method. It is concluded that pretest, in-situ, and post-test radiography can provide for a greater understanding of ceramic matrix composite mechanical behavior, a verification of related experimental procedures, and a validation and development of related analytical models. Author

N91-23040*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INDUSTRIAL APPLICATIONS OF GRAPHITE FLUORIDE FIBERS
Ching-Cheh Hung and Donald Kucera (Cleveland State Univ., OH.) *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 156-164 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 11D

N91-23041*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
UNIQUE APPLICATIONS OF FLUOROEPOXY MATERIALS
Sheng Yen Lee *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 165-172 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 11D

N91-23048*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COST-EFFICIENT MANUFACTURING OF COMPOSITE STRUCTURES
W. Tom Freeman, John G. Davis, and Norman J. Johnston *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 221-230 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 11D

N91-23049*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RAPID INDUCTION BONDING OF COMPOSITES, PLASTICS, AND METALS
John D. Buckley and Robert L. Fox *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 231-240 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 11D

25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics.*.

N91-22403 California Univ., Davis.
AN EXPERIMENTAL AND COMPUTATIONAL STUDY ON THE PROPAGATION AND KINETIC STRUCTURE OF LAMINAR PREMIXED FLAMES Ph.D. Thesis
Fokion Egolfopoulos 1990 209 p
Avail: Univ. Microfilms Order No. DA9102072

The steady propagation and chemical kinetic structure of adiabatic planar, laminar premixed flames were experimentally and numerically studied with systematic and extensive variations of the effects of fuel, oxidizer, pressure, stoichiometry, and flame temperature. Experimentally, the laminar flame speeds were determined by using the counterflow twin-flame configuration with laser Doppler velocimetry probing and systematic elimination of flame stretch effects. Numerical simulation was conducted by using validated hydro and transport codes together with various detailed chemical kinetic mechanisms. The parameter matrix of investigation included: (1) H2, CO, CH4, all C2-hydrocarbons, and C3H8 as fuels; (2) He, Ar, N2, and CO2 as inert diluents; (3) pressure variations from 0.2 to 4.5 atmospheres; (4) stoichiometry from very fuel lean to very fuel rich; and (5) flame temperature from 1550 to 2250 K varied independently of stoichiometry. An independent study of the phenomena of flammability limits was conducted. Experimentally, limits of propagation of unstretched flames were determined by first measuring the extinction limits of stretched, counterflow flames and extrapolating the results to zero stretch. Consequently, lean and rich flammability limits were determined for a large variety of mixtures. By further hypothesizing that the limit phenomena are primarily controlled by the kinetic processes of chain branching versus termination, a predictive theory was advanced for the a priori determination of flammability limits. Conclusions based on the results of the study are presented.
Dissert. Abstr.

N91-22404 Brown Univ., Providence, RI.
A NUMERICAL STUDY OF IGNITION LIMITS FOR METHANE-AIR MIXTURES Ph.D. Thesis
Abdelkader Frendi 1990 264 p
Avail: Univ. Microfilms Order No. DA910766

A detailed numerical study on ignition limits for methane-air mixtures is performed, using two mathematical models. One model allows the pressure to be uniform. The effect of the initial pressure wave induced by the spark on flame propagation is analyzed. The dependence of the minimum ignition energy for a stoichiometric methane-air mixture on the ignition parameters is studied in great detail. The value of the minimum ignition parameters is studied in great detail. The value of the minimum ignition energy is found to depend on the initial blast wave for short ignition times. It is also found that for small ignition kernels, the minimum ignition energy remains constant as the kernel size is decreased. Heat diffusion is found to contribute to the increase in minimum ignition energy for long ignition times, but it helps ignite the mixture for small kernel sizes. A minimum ignition energy 70 times smaller than the reported experimental value is found. The existence of a lean flammability limit for methane-air mixtures in the absence of gravity is then proven. It is found that when radiation heat loss from CO2 and H2O band emission is accounted for, a mixture limit is reached below which no flame propagates. A small but non-zero limit burning velocity is obtained at this limit. For sublimit mixtures, a special type of flame propagation known as self-extinguishing flames is found. The numerical results are compared to the available experimental data, and the agreement is generally good.
Dissert. Abstr.

N91-22405# Systems Research Labs., Inc., Dayton, OH.
COMBUSTION DIAGNOSTIC DEVELOPMENT AND APPLICATION, VOLUME 2 Final Report, 16 Sep. 1985 - 16 Jun. 1990
L. P. Goss and G. L. Switzer Nov. 1990 208 p
(Contract F33615-85-C-2562)
(AD-A231493; SRL-6890-Vol-2; WRDC-TR-90-2094-Vol-2) Avail: NTIS HC/MF A10 CSCL 21/2

Numerous advanced combustion-diagnostic techniques have been developed evaluated for flame studies. These techniques include a combined coherent anti-Stokes Raman spectroscopy (CARS)/laser Doppler velocimetry (LDV) system for simultaneous temperature and velocity measurements; thin-filament-pyrometry (TFP) for high-speed, multi-dimensional thermometry; flame-visualization techniques REACTIVE Mie scattering (RMS), two-dimensional Rayleigh, and planar laser-induced fluorescence (PLIF) of the OH Radical for obtaining two-dimensional flame-structure information; two-color particle-imaging velocimetry (PIV) for two-dimensional velocity measurements in low- and high-speed flowfields; hardened CARS system for thermometry in large-scale combustion systems; and a combined CARS; phase Doppler particle analyzer (PDPA) system for temperature, velocity, and particle-size measurements in spray-combustion systems. In addition, the LDV techniques was utilized extensively for pointwise velocity measurements. These techniques were developed, evaluated, and applied to the study of turbulent combustion flames. Experimental results obtained with the advanced diagnostic instrumentation were used in the evaluation of several numerical flame models. Both small (Bunsen and jet diffusion flames) and large (6- and 10-in. -diam. combustors) systems were studied utilizing the advanced diagnostics techniques. GRA

N91-22406# Systems Research Labs., Inc., Dayton, OH.
COMBUSTION DIAGNOSTIC DEVELOPMENT AND APPLICATION, VOLUME 1 Final Report, 16 Sep. 1985 - 16 Jun. 1990
L. P. Goss and G. L. Switzer Nov. 1990 221 p
(Contract F33615-85-C-2562)
(AD-A231667; SRL-6890-Vol-1; WRDC-TR-90-2094-Vol-1) Avail: NTIS HC/MF A10 CSCL 21/2

Numerous advanced combustion-diagnostic techniques have been developed and evaluated for flame studies. These techniques include: (1) a combined coherent anti-Stokes Raman spectroscopy (CARS)/laser-Doppler velocimetry (LDV) system for simultaneous temperature and velocity measurements; (2) thin-filament-pyrometry (TFP) for high-speed, multi-dimensional thermometry; (3) flame-visualization techniques (reactive Mie scattering (RMS), two dimensional Rayleigh, and planar laser-induced fluorescence (PLIF) of the OH radical) for obtaining two-dimensional flame-structure information; (4) two-color particle-imaging velocimetry (PIV) for two-dimensional velocity measurements in low- and high-speed flowfields; (5) hardened CARS system for thermometry in large-scale combustion systems; and (6) a combined CARS/phase Doppler particle analyzer (PDPA) system for temperature, velocity, and particle-size measurements in spray-combustion systems. In addition, the LDV technique was utilized extensively for pointwise velocity measurements. These techniques were developed, evaluated, and applied to the study of turbulent combustion flames. Experimental results obtained with the advanced diagnostic instrumentation were used in the evaluation of several numerical flame models. Both small (Bunsen and jet diffusion flames) and large (6- and 10-in. diameter combustors) systems were studied utilizing the advanced diagnostic techniques. GRA

N91-22407# California Inst. of Tech., Pasadena.
INVESTIGATIONS INTO SHOCK-INDUCED ENHANCEMENT OF MIXING AND COMBUSTION IN SUPERSONIC BURNERS Final Report, 1 Oct. 1986 - 30 Sep. 1990
Frank E. Marble 30 Nov. 1990 22 p
(Contract F49620-86-C-0113)
(AD-A231750; AFOSR-91-0012TR) Avail: NTIS HC/MF A03 CSCL 21/5

Experiments were carried out in the GALCIT 17 in. shock tube to investigate the effectiveness of shock enhancement on the mixing rate of a cylinder of helium gas into the surrounding air. Laser induced fluorescence was employed to trace the time development of mixing using byacetal dye to mark the helium. The concentration of helium was reduced below 20 pct. of its initial value over 0.6 of the helium volume within less than one ms by a weak (M=1.1) shock. The results corresponded well to results of computational analysis. Details of the combustion within the vortex were investigated in large vortices, created by a pulsing technique in the Unsteady Combustion Facility. The results of this program were sufficiently promising to encourage the design, construction and test of a scramjet injector using the technique. GRA

N91-22408# Tulane Univ., New Orleans, LA. Medical Center.
FREE RADICALS OF BIOCHEMICAL IMPORTANCE, ATTACHMENTS 1, 2, 3 Final Report, 15 Aug. 1989 - 14 Oct. 1990
Carl Bernofsky 14 Dec. 1990 42 p
(Grant AF-AFOSR-0468-89; AF Proj. 2312)
(AD-A231821; AFOSR-91-0029TR) Avail: NTIS HC/MF A03 CSCL 07/4

Hypochlorous acid (HOCl) is a cytotoxic agent that arises from the hydrolysis of chlorine gas upon contact with atmospheric humidity of the moist environment of the lung. It is also formed endogenously in animals as an end product of oxygen metabolism by activated phagocytes, which produce it as a means of defense against foreign cells. Although HOCl is highly toxic, the mechanisms by which it exerts its toxicity is unclear. The principal investigator has found that adenine nucleotides react vigorously with HOCl to yield an unstable derivative that has been isolated and found to be associated with a free radical that is capable of forming oligomers. The research of the current period has been directed toward eludicating the structure of this unstable derivative and characterizing the nature of radical that it forms. GRA

N91-22409# North Carolina Univ., Chapel Hill. Dept. of Chemistry.
HOMOGENEOUS SOLUTION ELECTROCATALYSTS FOR CO2 REDUCTION Final Report, Apr. 1987 - Sep. 1990
Thomas J. Meyer 31 Jan. 1991 6 p
(Contract N00014-87-K-0430)
(AD-A231921) Avail: NTIS HC/MF A02 CSCL 07/4

The goal of the research funded by this grant was to develop new electrocatalysts for CO2 reduction, and to probe the fundamental mechanisms of the steps that lead to the reduction of CO2. As the title suggests, this initially involved the synthesis of soluble transition metal complexes. More recently, the inability of the homogeneous catalysts to reduce CO2 past the two-electron stage, and the results of mechanistic studies, led us to investigate heterogeneous systems that could access more than two electron equivalents. Our initial investigations led to the preparation of polypyridyl complexes of ruthenium, osmium, rhenium, iridium, and rhodium. This is presented in a one page document. GRA

N91-22410*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SYNTHESIS AND THERMAL PROPERTIES OF STRONTIUM AND CALCIUM PEROXIDES
Warren H. Philipp and Patricia A. Kraft (Cleveland State Univ., OH.) 1989 14 p Presented at the Annual Meeting of the American Inst. of Chemical Engineers, San Francisco, CA, 6-8 Nov. 1989
(Contract NCC3-111)
(NASA-TM-103725; E-5959; NAS 1.15:103725) Avail: NTIS HC/MF A03 CSCL 07D

A practical synthesis and a discussion of some chemical properties of pure strontium peroxide and calcium peroxide are presented. The general synthesis of these peroxides involves precipitation of their octahydrates by addition of H2O2 to aqueous ammoniacal Sr(NO3)2 or CaCl2. The octahydrates are converted to the anhydrous peroxides by various dehydration techniques. A

new x-ray diffraction powder pattern for CaO2 x 8H2O is given from which lattice parameters a=6.212830 and c=11.0090 were calculated on the basis of the tetragonal crystal system. Author

N91-22411*# Vanderbilt Univ., Nashville, TN. Dept. of Mechanical Engineering.
LASER RAMAN DIAGNOSTICS IN SUBSONIC AND SUPERSONIC TURBULENT JET DIFFUSION FLAMES Final Report
T. S. Cheng, J. A. Wehrmeyer, and Robert W. Pitz [1991] 191 p
(Grant NAG1-770)
(NASA-CR-188172; NAS 1.26:188172) Avail: NTIS HC/MF A09 CSCL 07D

Ultraviolet (UV) spontaneous vibrational Raman scattering combined with laser-induced predissociative fluorescence (LIPF) is developed for temperature and multi-species concentration measurements. Simultaneous measurements of temperature, major species (H2, O2, N2, H2O), and minor species (OH) concentrations are made with a 'single' narrow band KrF excimer laser in subsonic and supersonic lifted turbulent hydrogen-air diffusion flames. The UV Raman system is calibrated with a flat-flame diffusion burner operated at several known equivalence ratios from fuel-lean to fuel-rich. Temperature measurements made by the ratio of Stokes/anti-Stokes signal and by the ideal gas law are compared. Single-shot uncertainties for temperature and concentration measurements are analyzed with photon statistics. Calibration constants and bandwidth factors are used in the data reduction program to arrive at temperature and species concentration measurements. The results of these measurements are presented, and these simultaneous measurements of temperature and multi-species concentrations allow a better understanding of the complex turbulence-chemistry interactions and provide information for the input and validation of CFD models. Author

N91-22412# Technische Univ., Eindhoven (Netherlands). Lab. of Inorganic Chemistry.
A SPECTROSCOPIC STUDY OF SILICA GEL FORMATION FROM AQUEOUS SILICATE SOLUTIONS Ph.D. Thesis
Petrus Wilhelmus Joh Wijnen 1990 143 p Sponsored by Netherlands Dept. of Economic Affairs
(ETN-91-99164) Avail: NTIS HC/MF A07

A combined SAXS (Small Angle X-ray Scattering) and NMR (Nuclear Magnetic Resonance) spectroscopical investigation of the formation of silica gels from aqueous silicate solutions is presented. Principles of fractal geometry are reviewed. The formation of aqueous precursor solutions is investigated. Silicon 29 NMR results for the oligomerization of aqueous monosilicic acid at high pH values are discussed in terms of the intermediate silicate species formed in the oligomerization reactions. The influences of silica concentration and polyvalent cations on aggregation kinetics of aqueous silicate solutions are discussed. The role of cations at two pH values typical for silica gel preparation is reviewed. Structural aspects of transformations in the silica gel systems are discussed. The implications of ageing on the size and structural arrangement of primary building units are discussed and analyzed in terms of the combination of results obtained from solid state silicon 29 NMR, SAXS and gas adsorption techniques. The impact of the study on molecular chemical insight in silica gel formation is discussed. ESA

N91-22413# Technische Univ., Eindhoven (Netherlands).
OXIDATIVE COUPLING OF METHANE OVER LITHIUM PROMOTED MAGNESIA Ph.D. Thesis
Johannes Maria Nicol vanKasteren 1990 84 p Sponsored by Netherlands Organization for Applied Scientific Research TNO, Delft and Commission of the European Communities
(ETN-91-99216) Avail: NTIS HC/MF A05

The direct conversion of methane into ethylene via the oxidative coupling process, where methane is converted into ethylene and water with the aid of oxygen in the prescence of a catalyst, is studied. Focus is on the lithium doped magnesia (Li/MgO) catalyst. Attention for the preparation method of this catalyst, the working principle and the influence of this catalyst on the methane conversion are studied extensively. A good insight into the working principle of the catalyst Li/MgO for direct conversion is provided. Li/MgO is shown to offer perspectives for future use provided that improvement of the stability of the catalyst is achieved. ESA

N91-22414# Helsinki Univ. of Technology, Espoo (Finland). Lab. of Physical Chemistry and Electrochemistry.
THE ELECTROCHEMISTRY OF LEAD, ANTIMONY, AND LEAD-ANTIMONY ALLOYS IN SULFURIC ACID SOLUTIONS Ph.D. Thesis
Timo Laitinen Oct. 1990 30 p Sponsored by Finnish Academy of Technology, Helsinki; Bulgarian Academy of Sciences; Foundation of Technology; Helsinki Univ., Finland; Neste Oy; Hilma and Heikki Honkanen Foundation; and Oskar Oeflund Foundation
(ETN-91-99261) Avail: NTIS HC/MF A03

The effect of Sb on the electrochemical behavior of Pb in H2SO4 solutions is clarified using two different approaches. First, Sb is found to increase the rate constant for the parabolic growth of oxide on Pb in the PbO2 potential region. This indicates that the presence of Sb increases the diffusion rate of oxygen species in the Pb oxide layer. Second, the electrochemical behavior of pure Pb, pure Sb, and Pb-Sb eutectic is investigated from a mechanistic point of view. The release of soluble Pb(IV) species into H2SO4 during the polarization of Pb is proved, and their role is discussed. A mechanism for the dissolution of Sb is suggested. Only trivalent soluble and solid oxidation products of Sb are detected, even at potentials well above the equilibrium potential of the Sb(V)/Sb(III) couple. Sb is found to affect the electrochemical behavior of Pb both via the formation of a doped Pb oxide or a mixed Pb-Sb oxide, which improves the conductivity of the anodic layer, and via the adsorption of Sb species on the oxidation products of Pb. ESA

N91-22415# Los Alamos National Lab., NM.
TRANSIENT THERMAL ANALYSIS FOR PHOTOTHERMAL SPECTROSCOPY USING ZEEMAN INTERFEROMETRY
D. B. Hiller (Washington State Univ., Pullman.) and R. G. Johnston 1991 7 p Presented at the 5th National Conference on Undergraduate Research, Pasadena, 21-23 Mar. 1991
(Contract W-7405-eng-36)
(DE91-009948; LA-UR-91-854; CONF-9103136-2) Avail: NTIS HC/MF A02

A new method of photothermal spectroscopy is introduced for measuring the weak absorption of light by liquids. This paper discusses the analysis for the time-varying Gaussian heating profile induced in a sample by laser heating. The advantages of this new Zeeman technique is that it is experimentally simple, yet less model dependent and at least as sensitive as competing methods. DOE

26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

N91-22416*# Alabama Univ., Birmingham. Dept. of Materials Science and Engineering.
INFLUENCE OF A MAGNETIC FIELD DURING DIRECTIONAL SOLIDIFICATION OF MAR-M 246 + Hf SUPERALLOY Final Technical Report
J. Barry Andrews, Wendy Alter, and Dianne Schmidt (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.) Jan. 1991 59 p
(Contract NAS8-36461)
(NASA-CR-184114; NAS 1.26:184114) Avail: NTIS HC/MF A04 CSCL 11F

An area that has been almost totally overlooked in the optimization of properties in directionally solidified superalloys is the control of microstructural features through the application of a magnetic field during solidification. The influence of a magnetic

field on the microstructural features of a nickel-base superalloys is investigated. Studies were performed on the dendritic MAR-M 246+Hf alloy, which was solidified under both a 5 K gauss magnetic field and under no-applied-field conditions. The possible influences of the magnetic field on the solidification process were observed by studying variations in microstructural features including volume fraction, surface area, number, and shape of the carbide particles. Stereological factors analyzed also included primary and secondary dendrite arm spacing and the volume fraction of the interdendritic eutectic constituent. Microprobe analysis was performed to determine the chemistry of the carbides, dendrites, and interdendritic constituents, and how it varied between field and no-field solidification samples. Experiments involving periodic application and removal of the magnetic field were also performed in order to permit a comparison with structural variations observed in a MAR-M 246+Hf alloy solidified during KC-135 high-g, low-g maneuvers. Author

N91-22417# Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS.
MINERALOGICAL FINGERPRINTS FOR CORROSION PROCESSES INDUCED
M. B. McNeil, J. M. Jones, and B. J. Little 1990 27 p
(AD-A229840) Avail: NTIS HC/MF A03 CSCL 11/6

Mineralogical data, thermodynamic stability (Pourbaix) diagrams, and the simplexity principle for precipitation reactions are used to rationalize corrosion product mineralogy in a variety of situations involving both fresh and saline water and to demonstrate the action of sulfate reducing bacteria (SRB) in these cases. Methods for using corrosion product mineralogy as a diagnostic tool for microbiologically influenced corrosion (MIC) are discussed. Many sulfides under near-surface biosphere conditions can only be produced by microbiological action on specific precursor materials such as metals. If a corrosion process can be shown to have taken place in a pH-Eh range typical of near-surface biosphere conditions and no compelling kinetic arguments can be adduced, mineralogical and geochemical data indicate that the presence of these minerals as corrosion products implies that sulfate reducing bacteria (SRB) were active. GRA

N91-22418 New Mexico State Univ., Las Cruces.
METALS COMBUSTION AT HIGH OXYGEN PRESSURE IN NORMAL GRAVITY AND REDUCED GRAVITY: MODEL AND EXPERIMENT Ph.D. Thesis
Theodore Aaron Steinberg 1990 307 p
Avail: Univ. Microfilms Order No. DA9101023

The combustion of metals under normal gravity and microgravity conditions was investigated. A model is presented that uses mass and enthalpy balances to describe the combustion occurring in the molten ball that forms during the combustion of iron rods. The effect of gravity in the postulated model was manifested in the time constant tau which defined the growth cycle of the molten ball: in normal gravity, tau was of regular frequency and magnitude and, in microgravity, tau became large since detachment did not occur. For the normal gravity combustion of iron rods, it was concluded that: (1) there was a large excess of oxygen contained in the molten balls; (2) combustion should occur upon entry of the liquid iron into the molten mass; and (3) oxygen intake into the molten ball was not limiting the combustion or regression rate of the melting surface. The metals tested in the cylindrical rod configuration in microgravity were flammable under similar conditions that support combustion in normal gravity, but the combustion physics were different. Dissert. Abstr.

N91-22419*# Clarkson Univ., Potsdam, NY. Center for Crystal Growth in Space.
MODELLING DIRECTIONAL SOLIDIFICATION Semiannual Progress Report No. 2, 1 Nov. 1990 - 30 Apr. 1991
William R. Wilcox 30 Apr. 1991 123 p
(Grant NAG8-831)
(NASA-CR-188155; NAS 1.26:188155) Avail: NTIS HC/MF A06 CSCL 11F

The long range goal of this program is to develop an improved understanding of phenomena of importance to directional solidification and to enable explanation and prediction of differences in behavior between solidification on Earth and in space. Current emphasis is on determining the influence of perturbations on directional solidification. For individual titles, see N91-22420 through N91-22421.

N91-22420*# Clarkson Univ., Potsdam, NY.
[RESULTS OF COMPOSITIONAL AND MICROSTRUCTURAL ANALYSES OF SOLIDIFIED INGOTS] Ph.D. Thesis
Mohsen Banan (MEMC Electronic Materials, Saint Peters, MO.) *In its* Modelling Directional Solidification 30 Apr. 1991 86 p (For primary document see N91-22419 14-26)
Avail: NTIS HC/MF A06 CSCL 11F

The results of compositional and microstructural analysis of solidified ingots are discussed. In the vibration section, the microstructural and compositional analysis of ingots solidified with and without vibration, the vibration induced dynamic acceleration measurements, and the macroscopic growth rate measurements using an interface demarcation technique are discussed. The Current induced Perturbation section includes the results of solidification of an ingot with alternating current pulses, the current interface demarcation in an alloy of In0.2Ga0.8SB, and in situ temperature measurements in the charges of GaSb and In0.2Ga0.8Sb during the passage of electric current. Author

N91-22421*# Clarkson Univ., Potsdam, NY. Center for Crystal Growth in Space.
DIRECTIONAL SOLIDIFICATION OF Pb-Sn EUTECTIC WITH VIBRATION
Rubens Caram, Mohsen Banan (MEMC Electronic Materials, Saint Peters, MO.), and William R. Wilcox *In its* Modelling Directional Solidification 30 Apr. 1991 16 p Previously announced as N91-20264 (For primary document see N91-22419 14-26)
Avail: NTIS HC/MF A06 CSCL 11F

Pb-Sn eutectic alloy was directionally solidified at 1.4 to 3.2 cm/hr with forced convection induced by axial vibration of the growth ampoule with a frequency of 10 to 40 Hz and an amplitude of 0.5 to 1.0 mm. To determine the exact growth rate, an interface demarcation technique was applied. The lamellar spacing was increased 10 to 40 percent in ingots solidified with vibration compared to those solidified without vibration. The average intensity of convection in the melt under axial vibration of the ampoule was estimated by comparing the experimental results with a theoretical model. Author

N91-22422# National Inst. of Standards and Technology, Boulder, CO.
ALUMINUM ALLOYS FOR ALS CRYOGENIC TANKS: OXYGEN COMPATIBILITY, VOLUME 2 Final Report, Nov. 1988 - Jun. 1990
Richard P. Reed, Nancy J. Simon, Joseph D. McColskey, Christopher N. McCowan, and Elizabeth S. Drexler Sep. 1990 128 p
(AD-A231830; NISTIR-3943; AL-TR-90-0630-Vol-2) Avail: NTIS HC/MF A07 CSCL 11/6

In part 2 of this program, selected tempers of alloys 8090, 2090, WL049, and 2219 were tested for compatibility with liquid oxygen in modified open-cup and pressurized mechanical-impact equipment at White Sands Test Facility. Drop height (potential energy), pressure, and environment (liquid oxygen, LOX, and gaseous oxygen, GOX) were varied in these tests. Additional promoted-combustion tests were also conducted at WSTF. Reactions, ranging in size from those that could be observed with the naked eye to those that required use of the scanning electron microscope (SEM), were identified in all alloys. Those that require little or no magnifying power to view are labeled macroreactions; those that require the use of optical microscopy or SEM are called microreactions. Al-Li alloys had more macroreactions than 2219; 2219 had more, or an equivalent number of microreactions than each of the Al-Li alloys. GRA

N91-22423# Lockheed Missiles and Space Co., Palo Alto, CA. Research and Development Div.
DEVELOPMENT OF FINE-GRAINED, DUCTILE TUNGSTEN ALLOYS FOR ARMOR/ANTI-ARMOR APPLICATION Final Report, 1 Oct. 1988 - 28 Feb. 1991
J. P. Wittenauer and T. G. Nieh 15 Jan. 1991 60 p
(Contract DAAL03-88-C-0031)
(AD-A231857; LMSC-F404866; ARO-26109.1-MS-A) Avail: NTIS HC/MF A04 CSCL 11/6

The objective of this program has been to develop and enhance the ductility of tungsten-based materials at high strain rates through the control of microstructural parameters such as grain size, distribution of phases, and texture. The technical basis for this objective is the close relationship between fine-structure and extended plasticity in metals and ceramics. To obtain a fine and equiaxed grain structure in tungsten-based materials, a number of processing routes have been evaluated under this program. Based upon a critical evaluation available processing schemes, four methods were selected to produce materials for detailed study. These processing methods included arc casting and thermomechanical processing of tungsten-based binary alloys, chemical vapor deposition, liquid phase sintering and consolidation of ultrafine powder. GRA

N91-22424# Ribbon Technology Corp., Gahanna, OH.
DIRECT CAST TITANIUM ALUMINIDE STRIP Final Report, 24 Jun. - 23 Dec. 1987
T. A. Gaspar and L. E. Hackman Jan. 1991 25 p
(Contract F33615-86-C-5139)
(AD-A231906; WL-TR-91-4002) Avail: NTIS HC/MF A03 CSCL 11/6

The purpose of the Phase 1 research project is to demonstrate the feasibility of melting titanium alloys using Duriron's induction slag melting process and casting them into rapidly solidified strip by RIBTEC's melt overflow process. The strip might be used for SiC-Ti metal matrix composites for advanced airframe structures. GRA

N91-22425# Army Lab. Command, Watertown, MA. Material Technology Lab.
SINTERABILITY OF TUNGSTEN POWDER CVD COATED WITH NICKEL AND IRON Final Report
Sharon Mulligan and Robert J. Dowding Nov. 1990 26 p
(AD-A231913; MTL-TR-90-56) Avail: NTIS HC/MF A03 CSCL 11/6

Three lots of tungsten powder coated with nickel and iron by chemical vapor deposition (CVD) were characterized as to its composition, particle size, and distribution. This was accomplished through the use of the scanning electron microscope (SEM) with a digital X ray dot mapping attachment. DC plasma emission, and Microtrac analysis. The sinterability of the powder was also evaluated through sintering trails of temperatures above and below the liquidus of the matrix phase. It was found that the coating of nickel and iron on the tungsten substrate was very uniform, but it was also difficult to obtain high sintered densities due to the near monosized nature of the powder. The highest sintered density obtained was 90 pct. of the theoretical value. It was concluded that to obtain full density a wider distribution of the particle size would be needed. GRA

N91-22426*# Martin Marietta Labs., Baltimore, MD.
SUPERPLASTIC FORMABILITY OF Al-Cu-Li ALLOY WELDALITE (TM) 049 Final Report
Bao-Tong Ma and Joseph R. Pickens Washington May 1991 78 p
(Contract NAS1-18531)
(NASA-CR-4367; NAS 1.26:4367; MML-TR-90-47c) Avail: NTIS HC/MF A05 CSCL 11F

Extensive research during the past decade shows that several aluminum lithium alloys can be processed to attain a microstructure that enables superplasticity. The high tensile stress of Al-Cu-Li alloy Weldalite (TM) 049 in the T4 and T6 tempers offers tremendous potential for attaining exceptional post-SPF (superplastic formability) properties. The used SPF material is Weldalite, which was shown to induce SPF behavior in other Al-Cu-Li alloys. The superplastic behavior and resulting post-SPF mechanical properties of this alloy, which was designed to be the next major structural alloy for space applications, were evaluated. The results indicate that Weldalite alloy does indeed exhibit excellent superplasticity over a wide range of temperatures and strain rates and excellent post-SPF tensile strength at various potential service temperatures. Author

N91-22427# Wichita State Univ., KS. National Inst. for Aviation Research.
SUPERPLASTICITY STUDY OF 1420 AND 1421 Al-Li ALLOYS
J. E. Talia Apr. 1991 18 p
(NIAR-91-12) Avail: NTIS HC/MF A03

A comparative study of superplasticity was performed on two Al-Li alloys, 1420 (Al-Li-Mg-Zr), and 1421 (Al-Li-Mg-Zr-Sc). For the as-recieved 1421, superplastic elongations were attained with a maximum elongation of 675 percent. However, less that 170 percent elongation was observed for the alloy 1420. The addition of Sc (.16 to .21 percent) in the alloy 1421 appears to be responsible for the superplastic elongation. Microstructural analysis was performed to find the pertinent mechanisms. Author

N91-22428# Wichita State Univ., KS. National Inst. for Aviation Research.
STRETCH FORMABILITY OF SHEETS OF Al-Li ALLOYS, PART 2
Amar Inchekel and J. E. Talia Mar. 1991 83 p
(Contract DAAL03-87-G-0003)
(NIAR-91-10) Avail: NTIS HC/MF A05

The effects of material parameters on the stretch formability of Al-Li 2091-T3 alloy were investigated. Special attention was accorded to the study of the effects of the strain hardening and the strain rate hardening on sheet metal formability. To this end, square grids were etched on the samples which were then pulled to failure in uniaxial tension in a servo-hydraulic testing machine. The tests were carried out at different strain rates to evaluate their effects. During the deformation of the specimens, photographs of the gauge length were taken at different time intervals. This technique allowed following of the strain distributions in the grids both in the longitudinal and transverse directions. The strain distributions with the stress-strain curves have given important information on the mechanical properties and the ability of the material to form. Among the properties are the plastic anisotropy, the critical strains at which instabilities occurred, the strain hardening exponent, etc. Furthermore, the failed specimens and their fracture surfaces were studied using scanning electron microscopy to determine the prevalent mode of failure and the variation of dislocation density along the specimen length using x rays. The lattice misalignment measured through the variation of the full width at half maximum (FWHM) is a clear indication of the dislocation density variation. It was found that the material deformed more at lower strain rates: whereas, the strength decreased. It was also found that the dislocation density decreased as the distance from the fracture surface increased. Author

N91-22429# Wichita State Univ., KS. National Inst. for Aviation Research.
EFFECTS OF SURFACE GENERATED SCRATCHES ON THE FATIGUE LIFE OF Al-Li ALLOYS, PART 1
Amar Inchekel and J. E. Talia Mar. 1991 106 p
(Contract DAAL03-87-G-0003)
(NIAR-91-9) Avail: NTIS HC/MF A06

An experimental investigation was performed to analyze the effects of surface generated scratches on the fatigue life of Al-Li alloy 2090. To this end, fatigue tests were conducted at room temperature on both notched and unnotched samples which were scratched using an end mill combined with a holding device. The scratches were defined by three parameters: tip radius of curvature, the scratch angle, and the scratch depth. The results indicated that all the parameters had significant effects with the least effect related to the scratch angle. Extensive reduction in the fatigue life

occurred as the scratch depth increased or the tip radius decreased. Further fatigue testing on the conventional aluminum alloys, 7075-T6 and 3303-h14, led to similar observations; thus, a basis for comparison between the alloys was provided. Moreover, the analysis of the fracture surface has unveiled different fatigue mechanisms and modes of failure: fatigue striations, foreign inclusion effect, tear mode, and slip mode at or near the scratch. These facts represent the underlying negative effects of the scratches on the fatigue properties of aluminum materials.

Author

N91-22430# Wichita State Univ., KS. National Inst. for Aviation Research.

A COMPARISON OF CORROSION FATIGUE PROPERTIES OF 6013 BARE, ALCLAD 2024 BARE ALUMINUM ALLOY SHEET MATERIALS

J. Chaudhuri, Y. M. Tan, K. Patni, and A. Eftekhari (Cessna Aircraft Co., Wichita, KS.) Mar. 1991 34 p

(NIAR-91-8) Avail: NTIS HC/MF A03

A corrosion fatigue test was performed on alclad 2024, 2024 bare and 6013 bare aluminum alloy sheet materials to compare their respective corrosion fatigue resistance. In addition, metallographic and scanning electron fractographic examinations of some of the tested specimens were performed to evaluate the mode of cracking and the nature of failure in these materials. It was found that the alclad 2024 material had a superior resistance to corrosion as compared to the 2024 bare and 6013 bare specimens, with the 2024 bare performing slightly better than the 6013. Fractographic and microstructural examinations showed that the clad layer of the alclad 2024 provided protection to its base metal from corrosion resulting into longer corrosion fatigue life. The lower corrosion fatigue life of the 6013 bare material was due to intergranular corrosion. Author

N91-22431# Wichita State Univ., KS. National Inst. for Aviation Research.

X RAY ROCKING CURVE ANALYSIS OF AGING AND DEFORMATION CHARACTERISTICS IN Al-Li ALLOYS

V. Gondhalekar, J. Chaudhuri, Amar Inchekel, and J. E. Talia Mar. 1991 14 p

(Contract DAAL03-87-G-0003)

(NIAR-91-5) Avail: NTIS HC/MF A03

A nondestructive x ray technique, the double crystal diffractometer method, is presented as a tool to investigate the aging and deformation characteristics of aluminum-lithium alloys. This method is extremely sensitive and can be used to measure strains and dislocation densities through the rocking curve half width. X ray data were used to correlate the different stages of the microstructure during aging and deformation. Models were also developed to describe the microstructure behavior of these alloys. Author

N91-22432*# Alabama Agricultural and Mechanical Coll., Normal. Dept. of Physics.

A STUDY OF MICROSTRUCTURAL CHARACTERISTICS OF Ni-BASED SUPERALLOYS AT HIGH TEMPERATURES Final Report

Ravindra B. Lal and M. D. Aggarwal Dec. 1990 67 p Original contains color illustrations

(Grant NAG8-076)

(NASA-CR-188047; NAS 1.26:188047; AAMU-NAG-003) Avail: NTIS HC/MF A04; 12 functional color pages CSCL 11F

The microstructural characteristics of the Ni-based superalloy MAR-M245(Hf) which is used in manufacturing the components of the Space Shuttle main engine are studied. These superalloys need optimum heat treatment to get the best results. To find out the optimum heat treatment, the techniques of differential thermal analysis (DTA) and the optical photomicrographs were utilized. In the first phase, the existing experimental equipment like cutting, grinding/polishing machines and metallurgical microscope were set up to cut/polish and take the photomicrographs. In the beginning of the project a Perkin Elmer differential thermal analyzer DTA1700 along with a temperature programmed and the needed computer interface was procured and made operational. In the second year a Leitz Metallux-3 hot state research microscope was also procured and installed for in-situ observation of the superalloy samples. The hot stage when tested for the first time alloyed the thermocouple with the Tantalum heating element and has now been installed. Samples of MAR-M246(Hf), MAR-M247, Waspaloy, Udimet-41, CMSX-3, and CMSX-3 (Polycrystalline and single crystals) were studied using a differential thermal analyzer and the results are reported. Photomicrographs of the Ni-based superalloy MAR-M246 (Hf) were recorded before and after heat treatment at certain temperatures. More heat treatments need to be done before a final inference can be reached. Author

N91-22433# Lawrence Livermore National Lab., CA.

FRACTURE BEHAVIOR OF WARM FORGED AND CVD TUNGSTEN

D. H. Lassila and A. Connor 14 Feb. 1991 21 p Presented at the Annual Meeting and Exhibition of the Minerals, Metals and Materials Society (TMS), New Orleans, 17-21 Feb. 1991

(Contract W-7405-eng-48)

(DE91-009756; UCRL-JC-106552; CONF-910202-8) Avail: NTIS HC/MF A03

The fracture behavior of warm forged and chemical vapor deposition (CVD) tungsten was studied. Three-point bend tests were used to determine ductile-brittle transition temperatures (DBTT) of the materials using a strain based criterion for the DBTT which was arrived at by analysis of computer code modelling results of the three-point bend test. The DBTT's of the warm forged materials were found to be considerably lower than those of the CVD materials. Scanning electron microscopy (SEM), scanning Auger electron spectroscopy (SAES) and X-ray photoelectron spectroscopy (XPS) were performed to characterize the fracture morphologies and fracture surface compositions of the materials. All fracture surfaces were found to be comprised entirely of tungsten with significant and varying amounts of oxygen and carbon segregation. A large portion of the fracture surfaces of the warm forged materials is intergranular, although this is not always directly evident from SEM observations. The fracture surfaces of the CVD materials were clearly 100 percent intergranular. Results of the study suggest that the fracture paths of the different materials were related to the DBTTs. DOE

N91-22434# California Univ., Berkeley. Lawrence Berkeley Lab.

CRYOGENIC MECHANICAL BEHAVIOR OF VINTAGE 3 ALUMINUM-COPPER-LITHIUM ALLOY 2090-T81 Ph.D. Thesis

D. Chu Dec. 1990 100 p

(Contract DE-AC03-76SF-00098)

(DE91-009776; LBL-30170) Avail: NTIS HC/MF A05

The cryogenic mechanical properties of a 12.7 mm (0.5 in.) Vintage 3 2090-T81 (Al-3.05Cu-2.16Li-0.11Zr in weight percent) plate material are studied. The results indicate that the through-thickness and in-plane anisotropies in the yield strength of Vintage 1 2090-T81 are reduced in the Vintage 3 material by utilizing a partial recrystallization step during the thermomechanical processing, but at some cost to the elongation and cryogenic fracture toughness. Sharp discontinuities in the microstructure resulting from this thermomechanical treatment give rise to distinct differences in the variation of the work hardening behavior with temperature between those regions that undergo recrystallization and those that do not. In-plane properties are also affected by the wide variation in grain structure; the fully unrecrystallized region exhibit greater in-plane anisotropy than the pre-crystallized region. The lower elongations relative to Vintage 1 2090-T81 observed in Vintage 3 2090-T81 result from a decrease in work hardenability that appears to be associated with increased slip heterogeneity. The reduced cryogenic toughness is due in part to the disruption of the monolithic unrecrystallized grain structure previously observed in Vintage 1 2090-T81. The results suggest that a fully unrecrystallized structure is essential for excellent cryogenic toughness. DOE

N91-22435# Colorado School of Mines, Golden. Center for Welding and Joining Research.
NOVEL CONCEPTS IN WELD METAL SCIENCE: ROLE OF GRADIENTS AND COMPOSITE STRUCTURE
D. K. Matlock and D. L. Olson Feb. 1991 26 p
(Contract DE-FG02-87ER-45308)
(DE91-009817; DOE/ER-45308/4; MT-CWR-091-005) Avail: NTIS HC/MF A03

The effects of compositional and microstructural gradients on weld metal properties are being investigated. Crack propagation in solidified alloy structures is being characterized as to solidification orientation and the profile of the compositional variations. Cracking in both Cu-Ni single crystals and high alloy Fe-Cr-Ni alloys are being analyzed. Emphasis is shifted from a consideration of natural gradients, which in weldments and castings are a direct result of solidification induced coring and the thermal history, to an analysis of a new novel class of welds with artificially induced gradients. The composite modeling techniques are being applied to describe the effects of compositional and microstructural gradients on weld metal properties in alloys. This effort has been extended to the analysis of several new weld metal systems of interest for joining new materials. A specific system of interest utilizes composites which may consist of a soft weld metal with insoluble hard second phase particles. Special techniques to produce laboratory samples with microstructures which simulate the composition and microstructure gradients in solidified weld metal are used, along with appropriate mathematical models, to evaluate the properties of the composite weld metals. DOE

N91-22436 Tel-Aviv Univ. (Israel). School of Chemistry.
METAL DEPOSITION ON ANODICALLY FORMED POROUS ALUMINUM OXIDE FILMS M.S. Thesis
Ariella Zagiel Jan. 1988 109 p In HEBREW; ENGLISH summary
(ITN-91-35094) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel

The aim is to elucidate the charge transfer mechanism through the protective oxide layer, during electrodeposition of metals on an oxide-coated aluminum surface. The study involved the deposition of copper and silver from divers solutions onto porous anodic films formed on 5052 Al, 1100 Al, and 4N Al alloys in 0.4 M phosphoric acid. The first stages of metal deposition into the pores were studied by applying different amounts of cathodic charge to the alloys under different conditions of pretreatment, current density, and temperature. Potential changes were monitored and the plated oxide surface was scanned with SEM. The anodic charge needed to strip the metal coating was compared with the charge used for the cathodic process. The ratio was found to be less than unity in all experiments; its value depended on the cathodic charge, which, in the case of copper, was strongly temperature dependent. In some cases, stripping was impossible. Chemical deposition experiments to examined the possibility of metal ion diffusion through the oxide layer beneath the pores showed that, under open-circuit conditions, the electrodes were only partially plated with chemically deposited metal, and SEM indicated that the first signs of chemically deposited metal appeared only after an hour in solution. Hence, diffusion of the ions through the oxide layer during the short period used for electrochemical deposition was unlikely. Analysis and XPS depth profiling of the elements found on both sides of separated oxide layers showed approximately the same concentration of deposited metal. In copper deposition from copper pyrophosphate solution and silver deposition from silver nitrate solution side reactions cause local pH increases, leading to chemical dissolution of the oxide beneath the pores and contact between the solution and the aluminum surface. It was found that, only for the case of direct contact between the Al and the deposited metal could the later be anodically stripped. During deposition from solutions in which the local dissolution reaction cannot occur, the main charge transfer mechanism, across the dense oxide layer at the bottom of the pores is ion migration under the influence of the applied electric field. ISA

N91-22909# Hamburg Univ. (Germany, F.R.).
THE SEGREGATION BEHAVIOR OF AlBi, AlPb AND AbIn MONOTECTIC ALLOYS FOR DIFFERENT CODING UNDER GRAVITY [DAS ENTMISCUNGSVERHALTEN DER MONOTEKTISCHEN LEGIERUNGEN AL-BI, AL-PB UND AB-IN BEI UNTERSCHIEDLICHER ABKUEHLUNG UNTER SCHWERKRAFT]
Xueli Wei (Academia Sinica, Shenyang, China) *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 179-181 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

27 NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

For composite materials see *24 Composite Materials.*

N91-22437 Oxford Univ. (England).
POLYMER BATTERY STUDIES Ph.D. Thesis
John C. H. Kerr 1989 323 p
Avail: Univ. Microfilms Order No. BRD90414

Conducting polymers are a new class of electrode materials for batteries. Two conducting polymers were successfully synthesized: the AB block copolymer polyisoprene copolyacetylene (PIPPA) and the low band-gap poly-benzo-(c) thiophene (PBCT). The attempted synthesis of the conducting polymer polytetrafluoro paraphenylene (4FPPP) is also presented; the synthetic route shows promise and needs further investigation. The electrochemistry of PIPPA, and the hitherto unsuspected electrochemistry of the PIP block are investigated using cyclic voltammetry and charge/discharge cycles. The copolymer's structure, both in its cast form and in solution, was studied using a combination of techniques: small angle neutron and x-ray scattering, neutron reflectivity, and electron microscopy. Battery tests on cast films of PIPPA indicated that with the relatively thick films used (approximately 0.2 mm), the slow charge and discharge of the copolymer is a potential problem. The electrodeposition of PIPPA form solution was demonstrated; this suggested the use of PIPPA in a type of vertical battery in which the PIPPA is reversibly electroplated. Aging of the copolymer to form micelles, and the consequences of this for PIPPA's battery action, are discussed. PBCT was electropolymerized in a manner which should minimize impurities and may lead to a simple process for the commercial fabrication of this polymer into lithium batteries. Combined ellipsometric and infrared (SNIFTIRS) work allowed thickness and electronic changes to be followed during the film's oxidation. Battery tests showed that in the 1M LiAsF6/sulfolane electrolyte used, the PBCT does no cycle reversibly. This work delineates the dual necessity for careful chemical and structural characterization of a polymer electrode to understand and optimize its battery action. Author

N91-22438# Dayton Univ., OH.
POLYMERIC MATERIALS FOR BATTERY APPLICATIONS Final Report, Aug. - Oct. 1990
Binod Kumar Jan. 1991 20 p
(Contract F33615-87-C-2714)
(AD-A231512; UDR-TR-90-96; WRDC-TR-90-2107) Avail: NTIS HC/MF A03 CSCL 01/2

This report presents state-of-the-art polymeric materials for battery applications. The specific topics of the report include: new materials, their formulation and characteristics, mechanisms of electrical conductivity and its temperature dependence, and patent literature. Potential research topics that will contribute to further development of science and technology of polymeric materials for electrochemical applications have also been identified. GRA

N91-22439# George Washington Univ., Washington, DC. Dept. of Chemistry.
EVIDENCE FOR VERTICAL C2 ON Ni AS A PRECURSOR FOR GRAPHITE NUCLEATION
David E. Ramaker Jan. 1991 16 p
(Contract N00014-89-J-1103)
(AD-A231672; TR-57) Avail: NTIS HC/MF A03 CSCL 20/5

We interpret previously published C K edge CEELS and NEXAFS data for carbon Ni between 500 and 700 K. The C K CEELS data for CO/Ni at 500 K reveal the presence of C-C bonding on the surface, i.e. horizontal Cn(n=2,3..). The CEELS data for carbon at 620 K reveal that some of the C2 species flip up at this temperature, while the others dissociate. Evidence for vertical C2 is seen only at higher carbon coverages suggesting that some of the C2 are forced to flip up to make room for neighboring horizontal C2's to dissociate. These vertical C2's then apparently serve as the precursor for the nucleation of graphite, as it explains the lack of graphite formation at lower coverages when total dissolution into the bulk occurs. GRA

N91-22440# George Washington Univ., Washington, DC. Dept. of Chemistry.
CEELS AS A PROBE OF THE CARBIDE TO GRAPHITE TRANSFORMATION ON Ni
David E. Ramaker Jan. 1991 11 p
(Contract N00014-89-J-1103)
(AD-A231675; TR-58) Avail: NTIS HC/MF A03 CSCL 07/4

Recent effective medium theory calculations indicate that a nucleation step must be involved in the carbide to graphite transformation on Ni, and that vertical C2 may be a precursor to this nucleation step. A similar nucleation site could also be involved in diamond formation on metals. We interpret previously published C K edge CEELS and NEXAFS data for carbon/Ni between 500 to 700 K. We make comparison with theoretical DOS calculations, and utilize CEELS angle dependencies to assign features and determine bond orientations on the surface. The results confirm that horizontal C(n), most likely C2, exists on the surface up 600 K, but that at 620 K, some of the species flip up. GRA

N91-22441# Wright Research Development Center, Wright-Patterson AFB, OH.
A USER'S MANUAL FOR FIBER DIFFRACTION: THE AUTOMATED PICKER AND HUBER DIFFRACTOMETERS Final Report, Jul. 1986 - Jun. 1990
P. G. Lenhert and W. W. Adams Jul. 1990 45 p
(AD-A231802; WRDC-TR-90-4069) Avail: NTIS HC/MF A03 CSCL 07/6

The automated Picker and Huber X ray diffractometer systems in use at the Materials Laboratory Polymer Branch is described. The diffractometer hardware is described from the user's point of view and a complete description is given of the use of the operations software for both the Picker and Huber systems. The control computer is a VAX 11/730. A device for applying tension to the fiber sample allows studies of the effect of tension fiber morphology as seen by diffraction methods. Analysis programs developed to process the diffraction data from the Picker Huber systems are explained and examples are given of program use, and in some cases, the results obtained are presented. An Appendix is included which contains a discussion of some of the hardware adjustments that may be required. The organization of the FORTRAN programs used by the VAX computer to control the diffractometer is explained. Utility programs for making various operational tests are also covered. GRA

N91-22442# Dayton Univ., OH.
X RAY DIFFRACTION STUDIES OF THE STRUCTURE OF ORDERED POLYMERS AND RELATED ELECTRO-ACTIVE MATERIALS Final Report, 1 Nov. 1987 - 30 Nov. 1990
Albert V. Fratini 31 Dec. 1990 161 p
(Grant AF-AFOSR-0044-88; AF Proj. 2303)
(AD-A231923; AFOSR-91-0032TR) Avail: NTIS HC/MF A08 CSCL 07/6

The structures of poly (p-phenylene benzo bisthiazole) (PBZT) and poly(p-phenylene benzo bisoxazole) (PBO) fibers have been determined by fiber diffraction techniques. D-spacings were obtained from equatorial and meridional scans recorded on a four-circle diffractometer. Intensity data were derived from x ray rotation patterns taken on Weissenberg and vacuum cylindrical cameras. Unit cells were found to be monoclinic and non-primitive, each containing two chains per cell. The conformational torsion angle between the bisthazole and phenylene units and the orientation of chains within the unit cells were obtained from a 'linked-atom least-squares' (LALS) refinement procedure. GRA

N91-22443# Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.
TOWARD A BLOCK-COPOLYMER-EMULSIFIED, TOUGH BLEND OF ISOTACTIC POLYSTYRENE AND POLYBUTADIENE: HIiPS
L. A. Cazzaniga and R. E. Cohen 14 Feb. 1991 37 p
(Contract N00014-91-J-1045)
(AD-A231934; TR-2) Avail: NTIS HC/MF A03 CSCL 07/6

Efforts to obtain mechanically tough compositions based on the brittle semicrystalline homopolymer isotactic polystyrene are summarized. The approach outlined includes the anionic synthesis of isotactic polystyrene (iPS) and diblock copolymers of iPS and polybutadiene (PB) rubber. The diblocks were successful in emulsifying pools of rubber in blends of iPS and PB. A micromechanical toughness test was developed and used to demonstrate the dramatically enhanced toughness of the emulsified blends over the toughness of either the iPS homopolymer or of binary blends of iPS and PB. GRA

N91-22444# Westinghouse Electric Corp., Pittsburgh, PA. Science and Technology Center.
RESEARCH ON SILICON, CARBON, AND SILICON CARBIDE HETEROSTRUCTURES Final Report, 1 Jul. 1987 - 31 Jul. 1990
W. D. Partlow, W. J. Choyke, John T. Yates, Jr., C. C. Cheng, and H. Gutleben 14 Sep. 1990 27 p
(Contract F49620-87-C-0101)
(AD-A231943; Rept-90-9S12-HETRO-R1; AFOSR-91-0011TR)
Avail: NTIS HC/MF A03 CSCL 09/1

The the accomplishments on this program in obtaining an understanding of the deposition of Group IV thin films by the remote plasma chemical deposition process (RPCVD) are described. The deposition process is characterized by emission spectroscopy and excited state absorption of resonance radiation by metastable states. Amorphous Si, C, SiC, and heterostructures of Si and SiC were deposited and characterized. The properties of the deposited films were related to the process parameters. UHV surface chemistry techniques were developed and applied to the study of fundamental deposition processes. A UHV cryogenic cathodoluminescence facility was developed and used to study crystalline diamond and RPCVD-deposited materials. GRA

N91-22445# Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.
EVALUATION OF DOMAIN SPACING SCALING LAWS FOR SEMICRYSTALLINE DIBLOCK COPOLYMERS
K. C. Douzinas, R. E. Cohen, and A. F. Halasa 28 Jan. 1991 21 p
(Contract N00014-91-J-1045)
(AD-A231958; TR-1) Avail: NTIS HC/MF A03 CSCL 07/6

Diblock copolymers of (ethylene-co-butylene)-b-(ethylene) (EBEE) were used to evaluate scaling laws describing the molecular weight dependence of the lamellar domain spacing of semi-crystalline block copolymer systems. Small angle X-ray scattering was used to measure lamellar domain spacings for a series of EBEE samples. Experimental results were in good agreement with the predictions of the equilibrium theory of Whitmore and Noolandi. GRA

N91-22446# Army Lab. Command, Watertown, MA. Material Technology Lab.
TRANSIENT CRYSTALLIZATION OF AN AROMATIC POLYETHERIMIDE: EFFECT OF ANNEALING Final Report

C. R. Desper, Alex J. Hsieh, and Nathaniel S. Schneider Jan. 1991 23 p
(AD-A231988; MTL-TR-91-1) Avail: NTIS HC/MF A03 CSCL 20/2

A systematic study using differential scanning calorimetry (DSC) has been performed on the annealing behavior of an aromatic polyethermide (Ultem 5001). Although crystallization from the melt did not occur, crystallinity was easily induced in the presence of methylene chloride. With annealing, a sharp melt endotherm of the solvent-treated polythermide was observed. The melt temperature determined after annealing for 30 minutes increased progressively as the annealing temperature increased leading after annealing to an extrapolation to an apparent equilibrium melt temperature of 369 C. However, the melt temperature, as well as crystallinity, increased with the increase of the residence time at each annealing temperature. GRA

N91-22447# Army Lab. Command, Watertown, MA. Material Technology Lab.
A PROPOSED STANDARD PRACTICE FOR FRACTOGRAPHIC ANALYSIS OF MONOLITHIC ADVANCED CERAMICS Final Report
George D. Quinn, Jeffrey J. Swab, and Michael J. Slavin Nov. 1990 51 p
(AD-A231989; MTL-TR-90-57) Avail: NTIS HC/MF A04 CSCL 11/4

The strength of many brittle ceramics reflects the flaws present in the material and the intrinsic fracture toughness. Interpretation of strength-test results for monolithic, brittle advanced ceramics requires fractographic analysis whether mechanical testing has done for quality control, materials development, or design purposes. Progress is presented on an effort to develop a standard practice for fractographic analysis of laboratory strength-test specimens. The primary goal is to encourage fractography as a complement to mechanical testing. Procedures will be developed with regard to inspection techniques, sampling criteria and reporting practices. The standard practice is in a formative state and the purpose of this report is to present its framework and solicit recommendations and comments. GRA

N91-22448*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THERMAL CHARACTERIZATION AND TOUGHNESS OF ETHYNYL CONTAINING BLENDS
Brian J. Jensen Apr. 1991 16 p
(NASA-TM-104071; NAS 1.15:104071) Avail: NTIS HC/MF A03 CSCL 11C

As part of an effort to develop high performance structural resins with an attractive combination of properties for aerospace applications, a series of ethynyl-terminated polysulfones of different molecular weights were prepared and blended with a low molecular weight ethynyl-terminated coreactant. Upon heating above 200 C, these ethynyl containing materials react to form a chain extended and crosslinked network structure. This reaction renders the materials insoluble in common solvents, but also reduces the toughness as compared to high molecular weight linear polysulfones. The thermal characterization of these blends and the toughness of the resulting cured materials are discussed. Author

N91-22449# Technische Univ., Eindhoven (Netherlands).
UNIAXIAL AND BIAXIAL DRAWING OF UHMW-POLYETHYLENE Ph.D. Thesis
Niclasina Siberta Jo Gerrits 1990 141 p
(ETN-91-99170) Avail: NTIS HC/MF A07

In order to interpret the deformation mechanisms during solid state drawing of UHMW (Ultra High Molecular Weight) PE (Polyethylene) in terms of crystal plasticity, general aspects such as slip systems, resolved shear stresses, and texture development are outlined. Texture development of uniaxially drawn melt crystallized and solution crystallized UHMW PE are studied by means of wide and small angle X-ray scattering and transmission electron microscopy. The tensile properties, morphology and deformation mechanisms of simultaneously biaxially drawn solution crystallized UHMW PE films are presented as a function of draw ratio. The influence of porosity in the undrawn solution crystallized films on the morphology and tensile properties of uniaxially and biaxially drawn samples is studied. Preliminary studies on other flexible polymers such as polypropylene and polyvinyl alcohol are described. This enables the findings on solid state deformation of PE to be extended to other polymers. ESA

N91-22450# Technische Univ., Eindhoven (Netherlands).
MODEL PREDICTION, EXPERIMENTAL DETERMINATION, AND CONTROL OF EMULSION COPOLYMER MICROSTRUCTURE Ph.D. Thesis
Gerardus Henricus Jo vanDoremaele 1990 226 p Sponsored by Stichting Scheikunding Onderzoek Nederland; DSM Research B.V.; and Shell Nederland B.V.
(ISBN-90-9003718-7; ETN-91-99171) Copyright Avail: NTIS HC/MF A11

An investigation of typical aspects of emulsion copolymerization aiming at a better and more quantitative understanding of the effects of the process parameters on the chemical microstructure of the copolymer is presented. An emulsion copolymerization model which is used to quantitatively describe kinetics and microstructure is developed. Experimental techniques to determine the molar mass chemical composition distribution by means of gas chromatography are developed. Theoretical background and experimental results of the monomer partitioning are discussed. Results of a detailed study of the effect of composition drift during emulsion copolymerization on reaction kinetics are given. Experimentally determined chemical microstructures of emulsion copolymers are compared with model calculations. The control of copolymer microstructure is demonstrated. Attempts to prepare structured latex particles by means of multistage emulsion copolymerization of styrene with methyl acrylate or n-buthyl acrylate and an investigation of the morphology of S-MA latex particles prepared under non azeotropic conditions are reported. ESA

N91-22451# Technische Univ., Eindhoven (Netherlands).
DEFORMATION BEHAVIOUR OF ORIENTED POLYETHYLENE FIBRES Ph.D. Thesis
Leonard Eduard Govaert 1990 116 p
(ETN-91-99179) Avail: NTIS HC/MF A06

A phenomenological approach to the deformation behavior of UHMW-PE (Ultra High Molecular Weight-Polyethylene) fibers, which shows that basically a distinction can be made between a linear, reversible (delayed elastic) contribution and a strongly nonlinear irreversible (plastic) flow contribution, is introduced. The time and temperature dependence of the reversible, delayed elastic and the plastic flow contributions to the deformation are studied and mathematically characterized. The obtained stress strain relationship is verified in stress relaxation, constant and rate and recovery experiments at 30C. The stress strain relationship is extended to cover temperature and time ranges where both the reversible and plastic flow contributions are significant. Focusing on dynamic behavior, an attempt to rationalize the deformation behavior of gel spun ultradrawn UHMW-PE fibers on a molecular basis is presented. A mathematical tool to evaluate the viscoelastic behavior of a hybrid composite on the basis of the viscoelastic characteristics of its components is presented. ESA

N91-22452# Technische Univ., Eindhoven (Netherlands).
SINTERING BEHAVIOUR AND PROPERTIES OF BETA'-Si3Al3O3N5 CERAMICS Ph.D. Thesis
Esther Kokmeijer 1990 150 p
(Grant IOP-TK-86-A035)
(ETN-91-99181) Avail: NTIS HC/MF A07

A study to optimize different production routes for beta'-Si3Al3O3N5 and to investigate the influence of the production process parameters and additives on the properties of the product is presented. Production methods used were reaction sintering in a gas pressure furnace, reaction hot pressing and sintering of sialon powder derived from kaolin. Reaction sintering of mixtures of Si3N4, Al2O3 and AlN with only small amounts of CeO2 or

CaO addition can produce high density beta'-Si3Al3O3N5. Samples without additive can only be densified by hot pressing. A mechanism comprising the decomposition of mullite and carbon into SiC and Al2O3, whereafter these compounds react with nitrogen to beta'-Si3Al3O3N5 and 15R, is found for the carbothermal production. A study of the influence of the pellet diameter on the reaction rate resulted in the determination of a critical pellet diameter. After thorough milling, the sialon prepared by carbothermal reaction from kaolin can be sintered to high density in 1 hour at 1690 C. The differences in the room temperature properties of the sialons produced are small. The wear behavior of sialon against ZrO2 is reported. The wear resistance of the 'kaolin' sialons is as good as that of the reaction sintered and hot pressed sialons. ESA

N91-22453# Wichita State Univ., KS. National Inst. for Aviation Research.
PREPARATION AND CHARACTERIZATION OF POLYELECTROLYTE COPOLYMERS CONTAINING METHYL METHACRYLATE AND 2-HYDROXYETHYL METHACRYLATE. PART 1: POLYMERS BASED ON METHACRYLIC ACID
William T. K. Stevenson, Shao Wen, and Xiaonan Yin 1991 32 p
(NIAR-91-4-pt-1) Avail: NTIS HC/MF A03

Acidic polyelectrolyte copolymers containing 2-hydroxyethyl methacrylate (HEMA), methyl methacrylate (MMA), and methacrylic acid (MAA) were prepared by free radical polymerization to high conversion in solution. Copolymer yields were obtained by gravimetry (all in the 30-50 percent range) relative molecular weights estimated by intrinsic viscosity measurements (all in the 50-70 cc/g range), tacticity by C-13 nuclear magnetic resonance (NMR) spectroscopy (all polymers were predominantly syndiotactic with some atactic content), and composition by acid/base titrations in conjunction with H-1 NMR spectroscopy (all close to the monomer charge ratios). Acid strength or apparent pKa's were examined as a function of extent of ionization. Measurements performed in water indicated that the compact/extended coil transformation in predominantly syndiotactic polymethacrylic acid occurres also in copolymers of similar tacticity containing moderate to high concentrations of MAA. The apparent pKa of such polymers containing only small amounts of MAA did not vary with extent of ionization, indicating a low degree of interaction between the acid groups. In copolymer pairs containing similar amounts of MAA but differing HEMA and MMA contents, the polymer containing more HEMA appeared the stronger acid, presumably due to a better solvation of that polymer which would increase the net spatial charge-charge separation, and decrease cooperative effects which lead to suppressed ionization. Author

N91-22454*# Clemson Univ., SC. Center for Advanced Engineering Fibers.
THERMOPLASTIC COATING OF CARBON FIBERS Final Report, 1990 - 1991
D. D. Edie and G. C. Lickfield 1991 96 p
(Grant NAG1-680)
(NASA-CR-188189; NAS 1.26:188189) Avail: NTIS HC/MF A05 CSCL 11C

Using a continuous powder coating process, more than 1500 meters of T 300/LaRC-TPI prepreg were produced. Two different types of heating sections in the coating line, namely electrical resistance and convection heating, were utilized. These prepregs were used to fabricate unidirectional composites. During composite fabrication the cure time of the consolidation was varied, and composites samples were produced with and without vacuum. Under these specimens, the effects of the different heating sections and of the variation of the consolidation parameters on mechanical properties and void content were investigated. The void fractions of the various composites were determined from density measurements, and the mechanical properties were measured by tensile testing, short beam shear testing and dynamic mechanical analysis. Author

N91-22455# Lawrence Livermore National Lab., CA.
DEVELOPMENT OF LOW DENSITY SILICA AEROGEL AS A CAPTURE MEDIUM FOR HYPER-VELOCITY PARTICLES
L. W. Hrubesh and J. F. Poco 1 Dec. 1990 14 p
(Contract W-7405-eng-48)
(DE91-008563; UCRL-CR-105858-Summ) Avail: NTIS HC/MF A03

The authors successfully demonstrated the production of monolithic bricks of transparent silica aerogel (2.5 x 4.5 x 16 cm) with densities as low as 0.003 g/cu cm. They have characterized the microstructure of these new ultra-low density aerogels, and determined that they are polymeric-like having crosslinked chains of silica as compared with the colloidal-like silica formed with the conventional sol-gel approach. They have determined that the new ultra-low density aerogels have a higher compressive modulus than would be expected from an extrapolation from the higher density aerogels, and they are typically 15 percent more transmissive than conventional aerogels for the wavelength range from 350 to 800 nm. The authors have developed a new method of casting regular shaped aerogels using silicone rubber molds. This new method eliminates irregular surfaces, for example the raised surface caused by a meniscus, in prior methods. Flat, and nearly parallel sides are obtained with the new method. They delivered 26 tiles of aerogels for the EURECA experiment. The nominal density of each tile was about 0.06 g/cu cm. Twenty of the tiles had dimensions of approximately 1.8 x 1.8 x 0.2 in., with flat sides. The remaining six tiles had dimensions of approximately 1.8 x 3.5 x 0.2 in. All tiles were shipped from LLNL to the University of Washington before September 30, 1990. DOE

N91-22456# Oak Ridge National Lab., TN.
EFFECT OF POST-SINTERING MICROWAVE TREATMENTS UPON THE MECHANICAL PERFORMANCE OF SILICON NITRIDE
M. K. Ferber, T. N. Tiegs, and M. G. Jenkins 1991 18 p
Presented at the 15th Annual Conference on Composites and Advanced Ceramics, Cocoa Beach, 13-16 Jan. 1991
(Contract DE-AC05-84OR-21400)
(DE91-009122; CONF-910162-6) Avail: NTIS HC/MF A03

Post sintering heat treatments were used to vary the microstructural characteristics in two types of hot-pressed silicon nitride. Particular emphasis was placed upon comparing changes in grain size, degree of crystallization of the intergranular phases, and chemistry of the intergranular phases resulting from conventional and microwave annealing. The effect of these post-sintering treatments upon the mechanical performance was evaluated by measuring the creep deflection in flexure as a function of time and applied stress at 1260 and 1370 C in air. DOE

N91-22457# Oak Ridge National Lab., TN.
GELCAST REACTION-BONDED SILICON NITRIDE COMPOSITES
O. O. Omatete, T. N. Tiegs, and A. C. Young 1991 15 p
Presented at the 15th Annual Conference on Composites and Advanced Ceramics, Cocoa Beach, 13-16 Jan. 1991
(Contract DE-AC05-84OR-21400)
(DE91-009134; CONF-910162-5) Avail: NTIS HC/MF A03

Nicalon fiber-reinforced, reaction-bonded silicon nitride (RBSN) composites were made by gelcasting green bodies of Si and fibers, and nitriding the composites in a 2.45-GHz microwave furnace. The bodies were prepared by casting a 48 volume percent slurry of silicon into a mold containing unidirectional fibers cut to the length of the mold. The extent of nitridation and the properties of the reaction-bonded silicon nitride composites were measured. Fracture surfaces of the composites processed at 1250 C for 8 hours showed significant fiber pullout; however, those nitrided at 1350 C for 4 hours exhibited only limited fiber pullout indicating possibly some degree of fiber degradation and strong matrix-fiber bonding. DOE

N91-22458# Tennessee Univ., Knoxville.
POLYMER-BASED SEPARATIONS: SYNTHESIS AND APPLICATION OF POLYMERS FOR IONIC AND MOLECULAR RECOGNITION
S. D. Alexandratos Apr. 1991 7 p
(Contract DE-FG05-86ER-13591)
(DE91-009516; DOE/ER-13591/5) Avail: NTIS HC/MF A02

The object of this research is to develop an understanding of the mechanisms by which polymers interact with ions and molecules in solution and, in doing so, design polymers with high levels of selectivity for target substrates. Thus, research continues for the synthesis of polymers with enhanced ionic and molecular recognition. Polymers studied and discussed include phosphinic acid resins, dimethyl amine/phosphinic acid, phosphonate monoester/diester resins, and sulfonic acid resins. DOE

N91-22459# California Univ., Berkeley. Lawrence Berkeley Lab.
DOPANT EFFECTS ON SINTERING BEHAVIOR IN CERAMIC MATRIX COMPOSITES Ph.D. Thesis
G. L. Brown Dec. 1990 69 p
(Contract DE-AC03-76SF-00098)
(DE91-009774; LBL-30220) Avail: NTIS HC/MF A04

Heterogeneities present one of the most serious problems in the processing of ceramic bodies. Non-uniformities in a ceramic, such as agglomerates, rigid inclusions, a wide particle size or pore size distribution, or spatial variations in green density can seriously affect sintering behavior, and experiments performed on highly uniform powder compacts have proven the importance of homogeneity within the compact. Powder compacts produced by conventional processing techniques, however, usually contain at least some of the inhomogeneities mentioned above. Particulate ceramic composites are currently being studied a great deal because of their improved fracture toughness and high-temperature creep resistance over single-phase ceramics. The presence of an inert second phase, however, has been found to hinder the densification of the matrix material seriously, even at low volume fractions of the inclusion phase, in a way that is to data not fully understood. Such techniques as hot pressing, hot isostatic pressing, or the incorporation of liquid-phase forming additives must therefore be used to obtain theoretical or near-theoretical densities; however it would be more convenient and more economical to free sinter these composites to full density. It is therefore important to obtain an understanding of the exact effects of heterogeneities on sintering, so that these effects may be countered. In this study, an attempt was made to more fully understand the effects of rigid, non-sinterable inclusions on densification in the ZnO-SiC system. DOE

N91-22460*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
STRUCTURAL DESIGN METHODOLOGIES FOR CERAMIC-BASED MATERIAL SYSTEMS
Stephen F. Duffy, Abhisak Chulya (Cleveland State Univ., OH.), and John P. Gyekenyesi Mar. 1991 14 p Submitted for publication .Original contains color illustrations
(Contract NCC3-89)
(NASA-TM-103097; E-5418; NAS 1.15:103097) Avail: NTIS HC/MF A03; 1 functional color page CSCL 11C

One of the primary pacing items for realizing the full potential of ceramic-based structural components is the development of new design methods and protocols. The focus here is on low temperature, fast-fracture analysis of monolithic, whisker-toughened, laminated, and woven ceramic composites. A number of design models and criteria are highlighted. Public domain computer algorithms, which aid engineers in predicting the fast-fracture reliability of structural components, are mentioned. Emphasis is not placed on evaluating the models, but instead is focused on the issues relevant to the current state of the art. Author

N91-23039*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HIGH PERFORMANCE POLYMER DEVELOPMENT
Paul M. Hergenrother *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 149-155 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 11C

N91-23042*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DUAL ION BEAM PROCESSED DIAMONDLIKE FILMS FOR INDUSTRIAL APPLICATIONS
M. J. Mirtich, M. T. Kussmaul (Sverdrup Technology, Inc., Brook Park, OH.), B. A. Banks, and J. S. Sovey *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 173-183 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 11C

N91-23043*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PLASMA-POLYMERIZED COATING FOR POLYCARBONATE: SINGLE-LAYER, ABRASION RESISTANT, AND ANTIREFLECTION
Theodore Wydeven *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 184-188 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 11C

N91-23044*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE PM-200 LUBRICATION SYSTEM
Harold E. Sliney *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 189-196 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 11C

28 PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion.*

N91-22461# Ballistic Research Labs., Aberdeen Proving Ground, MD.
THE MECHANICAL RESPONSE OF M30, XM39, AND JA2 PROPELLANTS AT STRAIN RATES FROM ONE ONE-HUNDREDTH TO 250 PER SECOND Final Report, 1989 Sep. - 1990 Feb.
George A. Gazonas Jan. 1991 43 p
(AD-A231435; BRL-TR-3181) Avail: NTIS HC/MF A03 CSCL 19/1

The mechanical response of M30, XM39, and JA2 gun propellants at strain rates from .01 to 250/sec is characterized using the BRL's new Hi-Rate Servohydraulic test apparatus. At axial strain rates of 250/sec, there is good experimental agreement between the compressive moduli determined on the drop weight and servohydraulic apparatuses, yet the post-yield responses vary because of differing displacement history inputs. All three propellants deformed in a ductile fashion and sustained over 40 percent shortening. The M30 and XM39 propellants deformed by macroscopic fracture and work-softened after reaching maximum stress. The JA2 propellant deformed by macroscopic flow and work-hardened throughout the deformation history. The absorbed strain energy density per unit volume at 30 percent shortening and strain rate of 250/sec, is 16 and 23 MPa for the XM39 and M30 propellants, respectively. In contrast, the absorbed strain energy density for the JA2 propellant is only 8 MPa and is due to the relatively low flow stress sustained by the material during deformation. A viscoelastic characterization reveals that the secant

and relaxation moduli for these propellants can be represented by a power law in time with nonlinear behavior in the time range from .01 to .0001 millisecs. GRA

N91-22462# Ballistic Research Labs., Aberdeen Proving Ground, MD.
THE EFFECTS OF COMPOSITION VARIATION AND NITRIC ACID ON THE STABILITY AND REACTIVITY OF THE HAN-BASED LIQUID PROPELLANTS Final Report, Jun. 1987 - May 1990
Nathan Klein, Charles S. Leveritt, and Paul G. Baer Jan. 1991 37 p
(AD-A231502; BRL-TR-3179) Avail: NTIS HC/MF A03 CSCL 19/1

The hydroxylammonium nitrate (HAN) based propellants, LGP1845 and LGP1845, are normally formulated from HAN, triethanolammonium nitrate (TEAN), and water. HAN:TEAN molar ratio is 7, the value required for N2 CO2 stoichiometry, and the amount of water present controls energy content and a number of the physical properties of the propellant. The effect of composition variation on performance was studied in order to gain insight into manufacturing specification limits. Nitric acid is a plausible impurity in these mixtures and its presence affects both the thermal stability and ballistic performance of the propellants. In addition, nitric acid, in small amounts, lowers the density of the mixtures thereby adversely affecting volumetric impetus. GRA

N91-22463# Illinois Univ., Urbana. Dept. of Mechanical and Industrial Engineering.
THE EFFECT OF PROPELLANT OPTICAL PROPERTIES ON COMPOSITE SOLID PROPELLANT COMBUSTION Final Report, Jul. 1987 - Dec. 1990
M. Q. Brewster Jan. 1991 411 p
(Contract N00014-87-C-0547)
(AD-A231631) Avail: NTIS HC/MF A18 CSCL 19/1

A synopsis of the results and the significance of the research program is summarized. (1) The optical properties of ammonium perchlorate (AP)-aluminum (Al) composite solid propellants are discussed. A model is developed to calculate propellant radiative properties. (2) The combustion characteristics of droplet burning rate and radiative emission are discussed. (3) In-situ light scattering and extinction measurements were used to determine the optical constants and size of Al2O3 in propellant flares. (4) Quench bomb tests, thermocouple temperature measurements, fiber optic radiation measurements, and rapid depressurization were used to investigate the influence of burning metals on the propellant combustion. (5) Initial progress has been made in developing a combustion model (using the oscillatory radiant heat flux method) so that radiant heat flux-coupled data can be converted to pressure-coupled data. Author

N91-22464*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MECHANISMS AND MODELING OF THE EFFECTS OF ADDITIVES ON THE NITROGEN OXIDES EMISSION
Krishna P. Kundu, Hung Lee Nguyen, and M. Paul Kang Jan. 1991 24 p Presented at the 29th Aerospace Sciences Meeting, Reno, NV, 7-10 Jan. 1991; sponsored in part by AIAA
(NASA-TM-103765; E-5969; NAS 1.15:103765; AIAA-91-0479) Avail: NTIS HC/MF A03 CSCL 20I

A theoretical study on the emission of the oxides of nitrogen in the combustion of hydrocarbons is presented. The current understanding of the mechanisms and the rate parameters for gas phase reactions were used to calculate the NO(x) emission. The possible effects of different chemical species on thermal NO(x), on a long time scale were discussed. The mixing of these additives at various stages of combustion were considered and NO(x) concentrations were calculated; effects of temperatures were also considered. The chemicals such as hydrocarbons, H2, CH3OH, NH3, and other nitrogen species were chosen as additives in this discussion. Results of these calculations can be used to evaluate the effects of these additives on the NO(x) emission in the industrial combustion system. Author

N91-22154*# Technische Univ., Berlin (Germany, F.R.). Aerospace Inst.
COMPARISON OF SUPER-HIGH-ENERGY-PROPULSION-SYSTEMS BASED ON METALLIC HYDROGEN PROPELLANT FOR ES TO LEO SPACE TRANSPORTATION
M. Thierschmann *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 211-227
(For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 21I

29 MATERIALS PROCESSING

Includes space-based development of products and processes for commercial applications.
For biological materials see *55 Space Biology.*

N91-22465*# Ohio State Univ., Columbus. Dept. of Chemical Engineering.
A FULL FIELD, 3-D VELOCIMETER FOR MICROGRAVITY CRYSTALLIZATION EXPERIMENTS Final Report
Robert S. Brodkey and Keith M. Russ Apr. 1991 57 p Original contains color illustrations
(Grant NAG3-1039; RF Proj. 767435/722039)
(NASA-CR-188147; NAS 1.26:188147) Avail: NTIS HC/MF A04; 2 functional color pages CSCL 22A

The programming and algorithms needed for implementing a full-field, 3-D velocimeter for laminar flow systems and the appropriate hardware to fully implement this ultimate system are discussed. It appears that imaging using a synched pair of video cameras and digitizer boards with synched rails for camera motion will provide a viable solution to the laminar tracking problem. The algorithms given here are simple, which should speed processing. On a heavily loaded VAXstation 3100 the particle identification can take 15 to 30 seconds, with the tracking taking less than one second. It seeems reasonable to assume that four image pairs can thus be acquired and analyzed in under one minute. Author

N91-22466*# National Aeronautics and Space Administration, Washington, DC.
MICROGRAVITY SCIENCE AND APPLICATIONS BIBLIOGRAPHY, 1990 REVISION
May 1991 78 p
(NASA-TM-4283; NAS 1.15:4283) Avail: NTIS HC/MF A05 CSCL 22A

This edition of the Microgravity Science and Applications (MSA) Bibliography is a compilation of government reports, contractor reports, conference proceedings, and journal articles dealing with flight experiments utilizing a low gravity environment to elucidate and control various processes, or with ground based activities that provide supporting research. It encompasses literature published but not cited in the 1989 Revision and that literature which has been published in the past year. Subdivisions of the bibliography include: electronic materials; metals, alloys, and composites; fluids, interfaces, and transport; glasses and ceramics; biotechnology; combustion science; and experimental technology, facilities, and instrumentation. Also included are publications from the European, Soviet, and Japanese programs. Author

N91-22884# Deutsche Agentur fuer Raumfahrtangelegenheiten G.m.b.H., Bonn (Germany, F.R.). Hauptabt. Forschung unter Schwerelosigkeit.
THE GERMAN MICROGRAVITY PROGRAM AND FLIGHT OCCURRENCES [DEUTSCHES MIKROGRAVITATIONSPROGRAMM UND FLUGGELEGENHEITEN]
H. Binnenbruck *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 1-12 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

N91-22895# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.).
USER SUPPORT AND GROUND SUPPORT PROGRAM, WITH THE EXAMPLE OF EURECA [NUTZERUNTERSTUETZUNG UND BODENBEGLEITPROGRAMM AM BEISPIEL VON EURECA]
B. Paetz and G. Otto *In its* Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 123-132 In ENGLISH and GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

N91-22896# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Inst. fuer Werkstoff-Forschung.
INVESTIGATION OF THE SHAPE OF THE SOLID-LIQUID PHASE FRONT IN THE BRIDGMAN-STOCKBARGER PROCESS [UNTERSUCHUNGEN ZUR FORM DER FEST-FLUESSIG PHASENFRONT BEIM BRIDGMAN-STOCKBARGER VERFAHREN]
U. Moeller *In its* Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 133-134 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

N91-22897# Erlangen-Nuremberg Univ. (Germany, F.R.). Lehrstuhl fuer Werkstoffe der Elektrotechnik.
GROWING OF GaAs MONOCRYSTALS AFTER THE FLOATING ZONE PROCESS UNDER MICROGRAVITY [ZUECHTUNG VON GAAS-EINKRISTALLEN NACH DEM FLOATING-ZONE-VERFAHREN UNTER MICROGRAVITY]
F. M. Herrmann *In* DLR, Fourth Summer School in Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 135-138 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

N91-22911# Freiburg Univ. (Germany, F.R.). Inst. fuer Kristallographie.
THE HEATER UNIT OF THE ZONE MELTING FACILITY (ZMF): A RESISTANCE HEATED TEN ZONE FURNACE [DIE HEIZEREINHEIT DES ZMF (ZONE MELTING FACILITY): EIN WIDERSTANDSBEHEIZTER ZEHNZOENOFEN]
R. Schwarz *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 191-192 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

N91-22913# Zentrum fuer Angewandte Raumfahrttechnologie und Mikronavigation, Bremen (Germany, F.R.).
ZARM: GENERAL INFORMATION [ZARM: ALLGEMEINE INFORMATION]
W. Guenther *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 197-202 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

N91-22467 Cranfield Inst. of Tech., Bedford (England).
A THEORETICAL AND EXPERIMENTAL STUDY OF A NOVEL REFRIGERANT COMPRESSOR Ph.D. Thesis
I. W. Eames 1989 437 p
Avail: Univ. Microfilms Order No. BRDX90882

A refrigerant compressor concept was envisaged consisting of a small scale centrifugal compressor driven by a high frequency induction motor on a common shaft with an impeller supported in aerodynamic bearings. The combination of state-of-the-art compressor, bearing and motor technologies potentially provides refrigerator designers with improved system performance and better compressor reliability with significant reductions in weight and physical size at reduced capital and running costs. A detailed description of the prototype compressor unit is included. The concept is compared with conventional compressor systems, and key areas of research requiring detailed investigation are identified. The following are described and/or evaluated: (1) the results of a literature survey into performance of centrifugal compressors; (2) the electric motor; (3) an investigation into the design of the drive shaft and bearing assemblies; (4) external and internal sources of machine vibration; (5) the manufacture of the prototype compressor unit; (6) testing of the compressor unit; (7) development problems encountered during testing; and (8) a computer simulation study of the behavior of a refrigeration system incorporating the prototype compressor. Aspects of the manufacture considered include surface finishes, tolerancing, heat treatments, and balancing processes. Dissert. Abstr.

N91-22468 Illinois Univ., Urbana-Champaign.
COORDINATION CONTROL OF FLEXIBLE MANUFACTURING SYSTEMS Ph.D. Thesis
Satheesh R. Menon 1990 273 p
Avail: Univ. Microfilms Order No. DA9026268

One of the first attempts was made to develop a model driven system for coordination control of Flexible Manufacturing Systems (FMS). The structure and activities of the FMS are modeled using a colored Petri Net based system. This approach has the advantage of being able to model the concurrency inherent in the system. It provides a method for encoding the system state, state transitions and the feasible transitions at any given state. Further structural analysis (for detecting conflicting actions, deadlocks which might occur during operation, etc.) can be performed. The problem is also addressed of implementing and testing the behavior of existing dynamic scheduling approaches in simulations of realistic situations. A simulation architecture was proposed and performance evaluation was carried out for establishing the correctness of the model, stability of the system from a structural (deadlocks) and temporal (boundedness of backlogs) points of view, and for collection of statistics for performance measures such as machine and robot utilizations, average wait times and idle times of resources. A real-time implementation architecture for the coordination controller was also developed and implemented in a software simulated environment. Given the current technology of FMS control, the model-driven colored Petri net-based approach promises to develop a very flexible control environment. Dissert. Abstr.

N91-22469# Army Construction Engineering Research Lab., Champaign, IL.
EVALUATION OF K-SPAN AS A RAPIDLY ERECTABLE LIGHTWEIGHT MOBILIZATION STRUCTURE (RELMS) Final Technical Report
Steven Sweeney, Demetres Briassoulis, and Anthony Kao Jan. 1991 65 p
(AD-A231699; CERL-TR-M-91/06) Avail: NTIS HC/MF A04
CSCL 13/3

To meet the increased need for facilities during a possible mobilization, the Army is evaluating new construction technologies for potential use as Rapidly Erectable Lightweight Mobilization Structures (RELMS). The K-Span building system was studied as one such technology. K-Span has many characteristics that would be beneficial for mobilization construction. Based on availability, K-Span could provide a small portion of early mobilization requirements. With 28 machines currently available to produce the systems, a maximum of 420,000 sq ft/day of bare structure could conceivably be completed with short lead time. To take full advantage of the rapid erectability of the system, enough steel would have to be stockpiled for about 2 weeks construction. After that time, the steel industry's ability to produce galvanized sheet steel would far exceed the capacity of the available K-Span equipment. GRA

N91-22470# Technische Univ., Eindhoven (Netherlands). Faculkteit Bouwkunde.
THE TREATISES OF JEAN NICOLAS LOUIS DURAND Ph.D. Thesis [DE TRACTATEN VAN JEAN NICOLAS LOUIS DURAND]
Gerard A. C. vanZeijl 1990 275 p In DUTCH
(ISBN-90-6814-517-7; ETN-91-99166) Copyright Avail: NTIS HC/MF A12

The treatises of Durand on architecture were studied in order to set them in a wider context. An attempt was made to demystify the negative image of Durand by presenting an honest judgement and a new interpretation. Many paradoxical statements were discovered, and discussed in the light of modern architecture. Seen from the topical architecture debate, a new image appeared, making Durand's theory transparent by the confrontation with those of some philosophers and architects today. ESA

N91-22172*# Michigan Technological Univ., Houghton. Dept. of Metallurgical and Materials Engineering.
A COMPARISON OF MICROWAVE VERSUS DIRECT SOLAR HEATING FOR LUNAR BRICK PRODUCTION
S. J. Yankee, D. G. Strenski, B. J. Pletka, D. S. Patil, and B. C. Mutsuddy *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 428-435 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 13H

N91-23051*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A SEMI-AUTOMATED PROCESS FOR THE PRODUCTION OF CUSTOM-MADE SHOES
Franklin H. Farmer *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 249-253 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13H

32 COMMUNICATIONS AND RADAR

Includes radar; land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Space Communications, Spacecraft Communications, Command and Tracking.* For search and rescue see *03 Air Transportation and Safety,* and *16 Space Transportation.*

N91-22471*# Notre Dame Univ., IN. Dept. of Electrical Engineering.
ERROR CONTROL TECHNIQUES FOR SATELLITE AND SPACE COMMUNICATIONS Semiannual Status Report, 1 Aug. 1990 - 31 Jan. 1991
Daniel J. Costello, Jr. Mar. 1991 229 p
(Grant NAG5-557)
(NASA-CR-187960; NAS 1.26:187960) Avail: NTIS HC/MF A11 CSCL 17B

Shannon's capacity bound shows that coding can achieve large reductions in the required signal to noise ratio per information bit (E sub b/N sub 0 where E sub b is the energy per bit and (N sub 0)/2 is the double sided noise density) in comparison to uncoded schemes. For bandwidth efficiencies of 2 bit/sym or greater, these improvements were obtained through the use of Trellis Coded Modulation and Block Coded Modulation. A method of obtaining these high efficiencies using multidimensional Multiple Phase Shift Keying (MPSK) and Quadrature Amplitude Modulation (QAM) signal sets with trellis coding is described. These schemes have advantages in decoding speed, phase transparency, and coding gain in comparison to other trellis coding schemes. Finally, a general parity check equation for rotationally invariant trellis codes is introduced from which non-linear codes for two dimensional MPSK and QAM signal sets are found. These codes are fully transparent to all rotations of the signal set. Author

N91-22472*# Ohio State Univ., Columbus. ElectroScience Lab.
THREE DIMENSIONAL SCATTERING CENTER IMAGING TECHNIQUES
P. R. Younger and W. D. Burnside Mar. 1991 143 p Sponsored in cooperation with Pacific Missile Test Center
(Grant NAG2-542)
(NASA-CR-188012; NAS 1.26:188012; ESL-TR-722780-2) Avail: NTIS HC/MF A07 CSCL 20N

Two methods to image scattering centers in 3-D are presented. The first method uses 2-D images generated from Inverse Synthetic Aperture Radar (ISAR) measurements taken by two vertically offset antennas. This technique is shown to provide accurate 3-D imaging capability which can be added to an existing ISAR measurement system, requiring only the addition of a second antenna. The second technique uses target impulse responses generated from wideband radar measurements from three slightly different offset antennas. This technique is shown to identify the dominant scattering centers on a target in nearly real time. The number of measurements required to image a target using this technique is very small relative to traditional imaging techniques. Author

N91-22473# National Severe Storms Lab., Norman, OK.
ENHANCEMENTS TO THE TERMINAL DOPPLER WEATHER RADAR GUST FRONT ALGORITHM Interim Report
Laurie G. Hermes, Kevin W. Thomas, Gregory J. Stumpf, Michael D. Eilts, Edward Brandes, ed., Dusan Zrnic, ed., Richard Doviak, ed., and Arthur Witt, ed. Dec. 1990 65 p Original contains color illustrations
(Contract DTFA01-80-Y-10524)
(DOT/FAA/NR-91/3) Avail: NTIS HC/MF A04

During the 1988 Operational Test and Evaluation of the FAA's Terminal Doppler Weather Radar (TDWR) system, a real-time test of the gust front algorithm capabilities in a High Plains environment (Denver, CO) was accomplished. Further evaluation of the algorithm's detection capability in the Great Planes (Kansas City, KA) was conducted in 1989. Deficiencies in several techniques used by the TDWR gust front algorithm were noted. As a result, modifications such as feature error checking and feature checking prior to polynomial fitting were included in the algorithm. Improvements to the techniques used to vertically associate features, determine gust front orientations, and to produce gust front representations and forecasts were also implemented. False algorithm detections, specifically those caused by the detection of radial convergence associated with low-level jet phenomenon, are discussed. Author

N91-22474 Stanford Univ., CA.
WAVE PROPAGATION IN ANISOTROPIC LAYERED COMPOSITES Ph.D. Thesis
Arthur Martins Barbo Braga 1990 162 p
Avail: Univ. Microfilms Order No. DA9102233

The propagation of harmonic waves in laminated anisotropic composites is investigated. The analysis is carried out within the framework of the linear theory of elasticity. Two basic geometries are considered, namely, layered half-spaces and infinite laminated plates. The method employed in the description of the wave motion in the anisotropic composites is based on Stroh's sextic matrix formalism for anisotropic elasticity. An extension of this formalism to periodic media, in conjunction with Floquet's theorem, is applied when the layers are disposed periodically. The 'in vacuo' free motions of laminated composites are investigated. Particular attention is paid to Rayleigh and Rayleigh-Lamb wave propagation in layered media. The dynamic interaction of laminated composites with a surrounding acoustic fluid is also investigated. The concept of surface impedance tensor is introduced. It is shown that, for harmonic motions, this rank-two tensor completely characterizes the solid surface in contact with the fluid. An algorithm for the numerical computation of the surface impedance tensor of anisotropic layered composites is presented. This algorithm is numerically stable for a wide range of frequencies. Special attention is paid to the subsonic Sholte-Gogoladze-like wave, which propagates unattenuated along the planar fluid/solid interface.
Dissert. Abstr.

N91-22475*# Stanford Univ., CA. Dept. of Psychology.
ANALYSIS OF ROUTINE COMMUNICATION IN THE AIR TRAFFIC CONTROL SYSTEM Final Report, Sep. 1989 - Aug. 1990
Herbert H. Clark, Daniel Morrow, and Michelle Rodvoid Aug. 1990 12 p
(Contract NCC2-622)
(NASA-CR-188116; NAS 1.26:188116) Avail: NTIS HC/MF A03 CSCL 17B

The present project has three related goals. The first is to describe the organization of routine controller-pilot communication. This includes identifying the basic units of communication and how they are organized into discourse, how controllers and pilots use language to achieve their goals, and what topics they discuss. The second goal is to identify the type and frequency of problems that interrupt routine information transfer and prompt pilots and controllers to focus on the communication itself. The authors analyze the costs of these problems in terms of communication efficiency, and the techniques used to resolve these problems. Third, the authors hope to identify factors associated with communication problems, such as deviations from conventional air traffic control procedures. Author

N91-22476# Colorado Univ., Boulder. Dept. of Electrical and Computer Engineering.
SUBSPACE SIGNAL PROCESSING IN STRUCTURED NOISE Ph.D. Thesis
Richard T. Behrens 1990 157 p
(Contract N00014-89-J-1070)
(AD-A231396; DSP-502) Avail: NTIS HC/MF A08 CSCL 12/9

Some common types of noise can be dealt with by applying a linear model to the noise as well as to the signal. The noise obeys a low-rank linear model as structured noise and derive several signal processing methods based on a structured noise model. Whereas orthogonal projection operators play a key role in the solution of classical linear estimation and detection problems, the addition of a structured noise term to the model leads to oblique projection operators in the new solutions. Consider several subspace identification problems in the context of a structured noise model. Also consider parameter estimation with structured noise, where the signal and structured noise subspaces are known or were identified from observed data. These results are applied to the decoding of complex number codes for detection and correction of impulse errors. GRA

N91-22477# Indiana Univ., Bloomington.
SPEECH PERCEPTION AND PRODUCTION IN SEVERE ENVIRONMENTS Final Report, Jul. 1986 - Jun. 1990
David B. Pisoni Sep. 1990 80 p
(Contract F33615-86-C-0549)
(AD-A231401; AAMRL-SR-90-507) Avail: NTIS HC/MF A05 CSCL 20/1

The goal was to acquire new knowledge about speech perception and production in severe environments such as high masking noise, increased cognitive load or sustained attentional demands. Changes were examined in speech production under these adverse conditions through acoustic analysis techniques. One set of studies focused on the effects of noise on speech production. The experiments in this group were designed to generate a database of speech obtained in noise and in quiet. A second set of experiments was designed to examine the effects of cognitive load on the acoustic-phonetic properties of speech. Talkers were required to carry out a demanding perceptual motor task while they read lists of test words. A final set of experiments explored the effects of vocal fatigue on the acoustic-phonetic properties of speech. Both cognitive load and vocal fatigue are present in many applications where speech recognition technology is used, yet their influence on speech production is poorly understood. GRA

N91-22478# Naval Postgraduate School, Monterey, CA.
TACTICAL HF FIELD EXPEDIENT ANTENNA PERFORMANCE, VOLUME 2 M.S. Thesis
Gurkan Turkes Mar. 1990 58 p
(AD-A231428) Avail: NTIS HC/MF A04 CSCL 09/1

This thesis investigates the performance of various configurations of tactical high frequency (HF) field deployable antennas in the presence of lossy earth. Antennas investigated include horizontal dipoles, short sloping wires, inverted vees, and monopoles with buried and elevated radials. Numerical models of the antennas are exercised via the Numerical Electromagnetic Code (NEC) for radiation pattern performance. Antennas are analyzed for applicability to the following: (1) short-range near vertical incident skywave (NVIS), where high elevation radiation angles are required; (2) medium- and long-range low radiation angle use; and (3) vertically polarized low-angle radiation for ground wave communication. Good NVIS and ground wave performance occurs for horizontal dipoles. Sloping wires and sloping dipoles are similar to horizontal dipoles but exhibit a moderate amount of azimuth plane directivity. Vertical monopoles with at least 15 buried radials produce medium- and long-range skywave coverage and good ground wave performance. Four elevated radials for quarter-wavelength monopoles are shown to out-perform 15 buried radials and are much easier to erect. The larger and more difficult-to-erect inverted vee dipole slightly outperforms a monopole by virtue of modest azimuth plane directivity. The results of this study can be included in an antenna engineering handbook and can be used to interface with existing ionospheric propagation codes in order to obtain optimum communication effectiveness GRA

N91-22479# Institute for Defense Analyses, Alexandria, VA.
TIRT STUDY NO. 9: STOKES VECTOR FORMALISM FOR THE SOURCE RADIANCE OF AN OPAQUE BODY Final Report, Jan. - Dec. 1990
Edwin C. Zimmermann and Amnon Dalcher Jan. 1991 36 p
(Contract MDA903-89-C-0003)
(AD-A231551; AD-E501348; IDA-P-2452; IDA/HQ-90-35776)
Avail: NTIS HC/MF A03 CSCL 20/3

A simple and rigorous formalism is presented for describing the incoherent radiative properties of absorption, emission, and scattering of an opaque body in local thermodynamic equilibrium; polarization, inelastic scattering, and applied magnetic field effects are treated in full. The radiative behavior of such a body is shown to be completely characterized by the local bispectral bidirectional reflectivity matrix. Expressions for the emitted and reflected Stokes vectors of the source radiation are given in terms of this matrix. Use is made of the most general forms of the reciprocal relations and Kirchhoff's law; derivations for these are also provided. GRA

N91-22480# Army Engineer Topographic Labs., Fort Belvoir, VA.
AUTOMATED EXTRACTION OF AIRPORT RUNWAY PATTERNS FROM RADAR IMAGERY Research Note, Jun. 1985 - Mar. 1989
Richard A. Hevenor and Pi-Fuay Chen Jun. 1990 41 p
(AD-A231809; ETL-0567) Avail: NTIS HC/MF A03 CSCL 17/9

A method is presented to extract linear terrain features from Synthetic Aperture Radar imagery. An input radar image is smoothed with an edge-preserving smoothing operation. Edge detection is performed using a Sobel operator, and both the magnitude and directional images are computed. The edges are then strengthened using several iterations of a relaxation operation in which both the magnitude image and the directional image are updated with each iteration. The output of the relaxation operation is a binary edge image, which is then thinned. A connected components routine is then run in which two passes through the image are used to provide a unique label for each connected component. The connected components related only to the runaway pattern are then extracted by computing certain properties of each component. A border-following algorithm is then used to follow only the outermost borders and give each of the pixels on an outermost border a maximum brightness value. A tracking

algorithm is used to change the binary image array into a set of Freeman chain codes, which serve as the input to a line-forming routine that uses a standard polygon approximation algorithm. Experimental results on a real synthetic aperture radar image are presented. GRA

N91-22481# Air Force Academy, CO.
ANTENNA AND BACKSCATTERING PATTERNS OF REFLECTORS THAT ARE PARTIALLY RESISTIVE Final Report, Jan. - May 1989
Randy L. Haupt Dec. 1990 58 p
(AD-A231825; RADC-TR-90-319) Avail: NTIS HC/MF A04 CSCL 17/4

This report examines the backscattering patterns and far field radiation patterns of two-dimensional corner reflector and parabolic reflector antennas for E-polarization. A surface integral equation formulation is employed to obtain the current density on a resistive reflector surface. The current is then integrated to obtain the radar cross section and far field receive radiation pattern. The same method is then used to calculate the scattering and radiation patterns of corner and parabolic reflector antennas with resistive surfaces. This analysis demonstrates that, when the entire reflector is resistive (rather than conducting) a reduction of the large backscattering lobes for front and back broadside incidence occurs along with a substantial reduction in gain. Tapering the resistivity of the surface, however, has little effect on the front and back backscattering lobes, but reduces the scattering sidelobes. The tapers significantly reduce the radiation pattern sidelobes with little reduction in gain. GRA

N91-22482# Lowell Univ., MA. Center for Atmospheric Research.
RESULTS OF A HIGH POWER OBLIQUE INCIDENCE HF IONOSPHERIC MODIFICATION EXPERIMENT Final Report, 24 Feb. 1987 - 15 Jun. 1990
Gary S. Sales, Ian G. Platt, and Yuming Huang Sep. 1990 45 p
(Contract F19628-87-K-0012)
(AD-A231893; ULRF-466/CAR; GL-TR-90-0219) Avail: NTIS HC/MF A03 CSCL 20/14

An oblique ionospheric modification experiment using a high power transmitter was carried out between Delano, CA and Shreveport, LA. A probe system, transmitting on a frequency close to that of the VOA heater signal was used to determine the effects of heating by observing the variation in its amplitude, angle of arrival and Doppler. A mid-point Digisonde was used for frequency management and as a HF radar for the detection of small scale heater-induced self-focussing irregularities. For this period VOA was not operating at its full power of 90 dBW so the experiment was largely considered as a fact finding exercise for future campaigns. As expected, data from both the probe system and Digisonde showed no unambiguous evidence as the heating cycle. Processed probe data for this period had significantly higher frequency spectral components than predicted and contaminate the spectra in the region near the heater cycle. These short period received signals are most likely due to naturally occurring structure in the ionosphere, such as multiple acoustic gravity waves, and the interference between the different propagation modes of the probe system. Digisonde drift data detected a large number of well defined large scale irregularities and gave a relatively smooth spectrum at higher frequencies. GRA

N91-22483# Texas Univ., Arlington.
EFFECT OF CELL SIZE ON RADAR CLUTTER STATISTICS Final Report, Oct. 1988 - Sep. 1989
Adrian K. Fung Sep. 1990 27 p
(Contract F30602-88-D-0025)
(AD-A231897; RADC-TR-90-235) Avail: NTIS HC/MF A03 CSCL 17/9

The objective of this study is to investigate through computer simulation the effects of a change in cell size on signal statistics in backward, forward and perpendicular directions of observation when a plane wave is incident at 70 degrees from the vertical on a randomly rough surface. It is found that in the backward direction the signal has a Weibull-like distribution and its mean and variance both decrease with an increase in the cell size starting with a cell less than 1.5 of a wavelength in dimension. When the cell size is around 7.3 lambda x 2.5 lambda, (lambda is the electric wavelength), the signal distribution approaches Rayleigh. In forward scattering the signal distribution is found to be closely Gaussian, and as cell size increases, the mean increases as expected. Variance increases also, but only slightly. In the perpendicular direction the signal distribution is again closely Weibull. Its mean and variance did not show any particular trends with a change in cell size. Author (GRA)

N91-22484# Army Lab. Command, Fort Monmouth, NJ. Electronics Technology and Devices Lab.
FREQUENCY STANDARDS FOR COMMUNICATIONS
Samuel R. Stein and John R. Vig Jan. 1991 71 p
(AD-A231990; SLCET-TR-91-2) Avail: NTIS HC/MF A04 CSCL 14/2

The fundamentals of quartz and atomic frequency standards are reviewed. The subjects discussed include: crystal resonators and oscillators, atomic oscillators, oscillator types, and the characteristics and limitations of temperature-compensated crystal oscillators (TCXO), oven-controlled crystals oscillators (OCXO), rubidium frequency standards, cesium beam frequency standards and hydrogen masers. The oscillator instabilities discussed include: aging, noise, frequency vs. temperature, warmup acceleration effects, magnetic field effects, atmospheric pressure effects, radiation effects, and interactions among the various effects. Guidelines are provided for oscillator comparison and selection. A discussion of time transfer techniques, and specifications are also included, as are references and suggestions for further reading. GRA

N91-22485# Beleidscommissie Remote Sensing, Delft (Netherlands).
EXPLORATIVE MEASUREMENTS ON THE POSSIBILITIES TO OBSERVE RIVER BOTTOM TOPOGRAPHY WITH SLAR
G. vanderBurg (National Aerospace Lab., Amsterdam, Netherlands) Nov. 1990 8 p
(BCRS Proj. OP-1.24)
(BCRS-90-23; ETN-91-99159) Avail: NTIS HC/MF A02

The results of an explorative study on the possibilities to observe river bottom topography with the Dutch digital SLAR (Side Looking Aperture Radar) are given. It is shown that under suitable conditions sea bottom topography is visible on radar images. In principle the imaging mechanism might equally well operate in case of sand dunes in riverbeds. However, due to the relatively small geometrical scales involved there are a number of restrictions that might limit the usefullness of SLAR imagery of riverbeds. Some of these restrictions are discussed. Moreover, the results of preliminary SLAR measurements of a small section of the river Waal/Boven Merwede are given. These measurements already suggest that the impact on the radar backscatter due to local inhomogeneities in the wind field (caused by high obstacles on the riverside) is such as to disrupt possible backscatter modulations associated with the underlying bottom topography. Therefore it is anticipated that radar imagery of riverbeds is only of limited value if used to locate sand dunes. ESA

N91-22486# Helsinki Univ. of Technology, Espoo (Finland). Electromagnetics Lab.
ANALYTICAL AND NUMERICAL METHODS IN ELECTROMAGNETIC DIFFRACTION PROBLEMS Ph.D. Thesis
Keijo I. Nikoskinen Nov. 1990 23 p Sponsored by Finnish Academy of Technology, Helsinki; Hilma and Heikki Honkanen Foundation; and Jenny and Antti Wihuri Foundation
(Rept-76; ISBN-951-22-0442-8; ISSN-0784-848X; ETN-91-99262) Avail: NTIS HC/MF A03

A survey of eight papers which introduce and discuss methods to solve electromagnetic scattering and diffraction problems is presented. A compact and favorable solution to the Sommerfeld problem in the time domain, in which an electromagnetic impulsive

dipole source interacts with a lossless half space characterized by permittivity and permeability, was obtained. The efficiency of the approach was shown by presenting 14 previously unknown closed form results obtained in certain specific cases. None of these results were derived using the Cagniard de Hoop method but instead very sophisticated and restricted methods were developed to solve the fields in these special geometries. This indicates that the Cagniard de Hoop method is better in a numerical than an analytical analysis. The approach introduced is equally good for both objectives and can be extended easily to nondispersive stratified structures like the Cagniard de Hoop method. ESA

N91-22487*# Hawaii Univ., Manoa. Dept. of Electrical Engineering.
CONCATENATED CODED MODULATION TECHNIQUES
Shu Lin 20 Apr. 1991 71 p
(Grant NAG5-931)
(NASA-CR-187891; NAS 1.26:187891; NASA-91-001) Avail: NTIS HC/MF A04 CSCL 20N

The topics discussed include the following: (1) single-level concatenated coded modulation NASA systems; (2) multi-level concatenated coded modulation; (3) single-level concatenated trellis-coded modulation (TCM) codes; (4) multi-level concatenated TCM codes; and (5) decoding of multi-level concatenated TCM codes. How large coding gains and high reliability can be achieved by using coded modulation with reduced decoding complexity is the basic question that is answered. K.S.

N91-22488# National Inst. of Standards and Technology, Boulder, CO. Electromagnetic Fields Div.
A BIBLIOGRAPHY OF THE NIST ELECTROMAGNETIC FIELDS DIVISION PUBLICATIONS
Ruth Marie Lyons, ed. and Kathryn A. Gibson, ed. Aug. 1990 104 p
(PB91-132241; NISTIR-3945) Avail: NTIS HC/MF A06 CSCL 20N

The bibliography lists the publications by the staff of the Electromagnetic Fields Division of the National Institute of Standards and Technology for the period Jan. 1970 through Jul. 1990. It supersedes PB90-163635 which listed the publications of the Electromagnetic Fields Division from Jan. 1970 through Aug. 1989. Topics covered include: antennas, dielectric measurements, electromagnetic interference, microwave metrology, noise , remote sensing, time domain, and waveform technology. Selected earlier publications from the division's predecessor organizations are included. GRA

N91-22489# National Inst. of Standards and Technology, Boulder, CO. Electromagnetic Technology Div.
METROLOGY FOR ELECTROMAGNETIC TECHNOLOGY: A BIBLIOGRAPHY OF NIST PUBLICATIONS
Mary E. DeWeese, ed. Aug. 1990 66 p
(PB91-132266; NISTIR-3946) Avail: NTIS HC/MF A04 CSCL 20N

The bibliography lists the publications of the personnel of the Electromagnetic Technology Division of NIST during the period from Jan. 1970 through publication of this report. Topics include: cryoelectronics, electromagnetic metrology, lasers, magnetics, optical fibers, and superconducting materials. A few earlier references that are directly related to the present work of the Division are also included. GRA

N91-22490# Sandia National Labs., Albuquerque, NM.
PHASED-ARRAY ANTENNA CONTROL BY A MONOLITHIC PHOTONIC INTEGRATED CIRCUIT
V. M. Hietala, G. A. Vawter, W. J. Meyer, and S. H. Kravitz 1991 7 p Presented at the SPIE International Symposium on Optical Engineering and Photonics in Aerospace Sensing, Orlando, 1-5 Apr. 1991
(Contract DE-AC04-76DP-00789)
(DE91-010479; SAND-91-0650C; CONF-910450-4) Avail: NTIS HC/MF A02

An optical based RF beam steering system is proposed for phased-array antenna systems. The system, COMPASS (Coherent Optical Monolithic Phased Array Steering System), is based on optical heterodyning employed to produce microwave phase shifting. At the heart of the system is a monolithic Photonic Integrated Circuit (PIC) constructed entirely of passive components. Microwave power and control signal distribution to the antenna is accomplished by optical fiber, thus separating the PIC and its control functions from the antenna. This approach promises to reduce size, weight, and complexity of future phased-array antenna systems. DOE

N91-22491# Fermi National Accelerator Lab., Batavia, IL.
HARD AMPLITUDES IN GAUGE THEORIES
S. J. Parke Mar. 1991 35 p
(Contract DE-AC02-76CH-03000)
(DE91-009769; FNAL/C-91/72-T) Avail: NTIS HC/MF A03

In this lecture series I presents recent developments in perturbation theory methods for gauge theories for processes with many partons. These techniques and results are useful in the calculation of cross sections for processes with many final state partons which have applications in the study of multi-jet phenomena in high-energy colliders. The results illuminate many important and interesting properties of non-abelian gauge theories. DOE

N91-22492# Argonne National Lab., IL.
FAST SHOWER SIMULATION BASED ON GAU(BETA)'S LAW
H. J. Trost 1 Mar. 1991 36 p
(Contract W-31-109-eng-38)
(DE91-009885; ANL-HEP-TR-91/17) Avail: NTIS HC/MF A03

I have developed a procedure for fast shower simulation on the basis of Gau(beta)'s law, applied in analogy to charge distributions and related vector fields of electromagnetic interactions. The nature of a shower (i.e. electromagnetic or hadronic), a homogeneous medium for its development, its starting point, direction and energy content need to be specified. Then the contribution from the shower to the total signal in any given volume made up of the given medium can be calculated as an integral over the surface of that volume using a precalculated vector field corresponding to the shower distribution. Thus the integration problem is reduced from three to two dimensions. The quality of the shower simulation is determined by the accuracies of the vector fields and of the surface integration. This technique is shown to yield acceptable results for typical sized of calorimeter cell structures. DOE

N91-22493# Los Alamos National Lab., NM.
HYBRID CODES: METHODS AND APPLICATIONS
D. Winske and N. Omidi (California Univ., San Diego, La Jolla.) 1991 74 p Presented at the 4th International School for Space Simulation, Nara, Japan, 1-5 Apr. 1991
(Contract W-7405-eng-36)
(DE91-009959; LA-UR-91-0911; CONF-9104109-3) Avail: NTIS HC/MF A04

In this chapter we discuss 'hybrid' algorithms used in the study of low frequency electromagnetic phenomena, where one or more ion species are treated kinetically via standard PIC methods used in particle codes and the electrons are treated as a single charge neutralizing massless fluid. Other types of hybrid models are possible, as discussed in Winske and Quest, but hybrid codes with particle ions and massless fluid electrons have become the most common for simulating space plasma physics phenomena in the last decade, as we discussed in this paper. DOE

N91-22494*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A STATISTICAL RAIN ATTENUATION PREDICTION MODEL WITH APPLICATION TO THE ADVANCED COMMUNICATION TECHNOLOGY SATELLITE PROJECT. 3: A STOCHASTIC RAIN FADE CONTROL ALGORITHM FOR SATELLITE LINK POWER VIA NON LINEAR MARKOW FILTERING THEORY
Robert M. Manning May 1991 23 p

(NASA-TM-100243; E-6171; NAS 1.15:100243) Avail: NTIS HC/MF A03 CSCL 20N

The dynamic and composite nature of propagation impairments that are incurred on Earth-space communications links at frequencies in and above 30/20 GHz Ka band, i.e., rain attenuation, cloud and/or clear air scintillation, etc., combined with the need to counter such degradations after the small link margins have been exceeded, necessitate the use of dynamic statistical identification and prediction processing of the fading signal in order to optimally estimate and predict the levels of each of the deleterious attenuation components. Such requirements are being met in NASA's Advanced Communications Technology Satellite (ACTS) Project by the implementation of optimal processing schemes derived through the use of the Rain Attenuation Prediction Model and nonlinear Markov filtering theory. Author

33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics*.

N91-22495*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

Q-CIRCLE MEASUREMENT ERROR

Chase P. Hearn and Edward S. Bradshaw Washington May 1991 14 p

(NASA-TM-4253; L-16821; NAS 1.15:4253) Avail: NTIS HC/MF A03 CSCL 09C

High-Q lumped and distributed networks near resonance are generally modeled as elementary three element RLC circuits. The widely used Q-circle measurement technique is based on this assumption. It is shown that this assumption can lead to errors when measuring the Q-factor of more complex resonators, particularly when heavily loaded by the external source. In the Q-circle technique, the resonator is assumed to behave as a pure series (or parallel) RLC circuit and the intercept frequencies are found experimentally at which the components of impedance satisfy the absolute value of Im(Z) = Re(Z) (unloaded Q) and absolute value of Im(Z) = Ro+Re(Z) (loaded Q). The Q-factor is then determined as the ratio of the resonant frequency to the intercept bandwidth. This relationship is exact for simple series or parallel RLC circuits, regardless of the Q-factor, but not for more complex circuits. This is shown to be due to the fact that the impedance components of the circuit vary with frequency differently from those in a pure series RLC circuit, causing the Q-factor as determined above to be in error. Author

N91-22496# Franklin Research Center, Norristown, PA.

SHORT PULSE TEST SET

Nov. 1990 22 p

(Contract DAAH01-85-C-1418)

(AD-A231119) Avail: NTIS HC/MF A02 CSCL 10/2

This report discusses the construction and operation of the Short Pulse Test Set that has been built for the U.S. Army Missile Command for the purpose of applying short (25 to 100 nanosecond), high voltage pulses to electronic explosive devices (EEDs) in both the pin-to-pin and pins-to-case mode. The test set employs the short pulse generating techniques first described in the Franklin Institute Research Laboratories (now Franklin Research Center) Report I-C3410, 'Pins-to-Case Short Pulse Sensitivity Studies for the Atlas DC Switch', December 1974. This report, authored by Ramie H. Thompson, was prepared for Picatinny Arsenal under contract DAAA21-72C-0766. The test set described herein utilizes a computer controlled high speed digitizer to monitor the pulse voltage and current and provides software to process and display these data. GRA

N91-22497# Army Lab. Command, Fort Monmouth, NJ. Electronics Technology and Devices Lab.

HOT ELECTRON STRESS TESTING OF SUBMICRON TRANSISTORS Technical Report, Mar. - Oct. 1988

Paul M. Restine Oct. 1990 50 p

(AD-A231518; SLCET-TR-90-9) Avail: NTIS HC/MF A03 CSCL 09/1

Hot electrons are a major reliability concern for submicron metal-oxide-semiconductor (MOS) transistors. This report details experimental results of long-term hot electron degradation. Theoretical explanation of test results is provided. The implications of these results with respect to the validity of long-term reliability predictions is also discussed. GRA

N91-22498# Army Lab. Command, Fort Monmouth, NJ. Electronics Technology and Devices Lab.

EQUIVALENT CIRCUITS FOR RESONATORS AND TRANSDUCERS DRIVEN PIEZOELECTRICALLY Technical Report, Jan. - Mar. 1990

Arthur Ballato Oct. 1990 39 p

(AD-A231520; SLCET-TR-90-12) Avail: NTIS HC/MF A03 CSCL 09/1

A powerful motivation for using equivalent circuits to characterize piezoelectric devices is that the using equipment is often itself completely electrical in nature. The whole ensemble thus becomes subject to analysis or synthesis from a single perspective, i.e., network theory. In this report are described a brief history of circuit equivalents through the Mason circuit, followed by a presentation of newer descriptions of piezoelectrically vibrating structures, specifically, analog networks and KLM circuits. GRA

N91-22499# Army Engineer Waterways Experiment Station, Vicksburg, MS. Inst. Services Div.

ANALYSIS OF WIDEBAND BEAMFORMERS DESIGNED WITH ARTIFICIAL NEURAL NETWORKS Final Report

Cary Cox Dec. 1990 254 p

(AD-A231668; WES/TR/O-90-1) Avail: NTIS HC/MF A12 CSCL 12/9

The ability to determine the direction of an approaching wave is demonstrated by using an artificial neural network and a beamformer array. To demonstrate the ability of a neural network to learn a satisfactory solution to this problem, simulations were performed to test the system's sensitivity to several variables. These variables include amplitude range, noise level, frequency bandwidth, linear and nonlinear inputs, the number of sensor inputs, and the number of hidden units used in the network. Simulations are provided for both narrow band and wideband signals. An empirical test and a comparison between ANN beamformers and FFT beamformers are also used to demonstrate the strengths and weaknesses of the system. A design example and a description of the simulation program are also included. A brief tutorial on beamformers and neural networks is also provided.

Author (GRA)

N91-22500# Maryland Univ., College Park. Lab. for Plasma Research.

EXPERIMENTAL AND THEORETICAL STUDIES OF HIGH POWER PLASMA FILLED BACKWARD WAVE OSCILLATORS Progress Report, 1 Aug. 1990 - 31 Jan. 1991

T. M. Antonsen, Jr., Y. Carmel, W. W. Destler, V. L. Granatstein, and B. Levush Feb. 1991 83 p

(Contract N00014-89-K-2030)

(AD-A231782) Avail: NTIS HC/MF A05 CSCL 09/1

The purpose of the research covered during this period was to study the behavior of a plasma loaded BWO when driven by large beam current approaching the vacuum space charge limiting value inside the device. The main results are: (1) The plasma indeed allows injection of large current into the BWO. Currents as high as 75 percent of the vacuum space charge limit were successfully propagated. (2) In plasma loaded BWO, in contrast to the vacuum case, the enhanced efficiency can be maintained even for large beam currents (approaching the vacuum limit). It is

anticipated that this might hold even well beyond the vacuum limit. (3) The output frequency is only slightly shifted (1-5 percent) by the presence of the plasma. (4) A foilless field emission diode can operate successfully in a background of low density plasma. (5) An important parameter, the start oscillation current was measured for the first time in vacuum BWO for various beam voltages and geometries. For example, at 600 kV the start current is under 140 A. (6) Initial indications are that the plasma increases the microwave pulse duration. (7) A novel field emission cathode design (new geometries and materials) allows for continuous control of the beam current in the range of 50 to 6000 Amps. Turn on fields below 50 kV/cm were achieved. (8) Linear theory for a plasma loaded BWO was developed (using a simplified model), and (9) A nonlinear theory for a finite length device was developed. GRA

N91-22501# Army Lab. Command, Fort Monmouth, NJ. Electronics Technology and Devices Lab.
EUROPEAN COOPERATIVE PROGRAMS AND THE US Technical Report, 1989 - 1990
Herbert L. Mette and Wolfgang Stahl Dec. 1990 23 p
(AD-A231799; SLCET-TR-90-17) Avail: NTIS HC/MF A03
CSCL 05/4

European cooperative programs are becoming increasingly important relative to those of individual nations. Infrastructures and databases were developed to manage these programs efficiently. Most of the database information is accessible on-line from the U.S. via telephone and data networks, and active participation by U.S. companies appears imminent. Civilian programs such as EUREKA were so successful that military programs such as EUCLID are being modeled after it.
Author (GRA)

N91-22502*# Hughes Research Labs., Malibu, CA.
HOLLOTRON SWITCH FOR MEGAWATT LIGHTWEIGHT SPACE INVERTERS Final Report, 28 Sep. 1989 - 2 Nov. 1990
R. L. Poeschel, D. M. Goebel, and R. W. Schumacher Mar. 1991 57 p
(Contract NAS3-25802)
(NASA-CR-187083; NAS 1.26:187083) Avail: NTIS HC/MF A04
CSCL 09A

The feasibility of satisfying the switching requirements for a megawatt ultralight inverter system using HOLLOTRON switch technology was determined. The existing experimental switch hardware was modified to investigate a coaxial HOLLOTRON switch configuration and the results were compared with those obtained for a modified linear HOLLOTRON configuration. It was concluded that scaling the HOLLOTRON switch to the current and voltage specifications required for a megawatt converter system is indeed feasible using a modified linear configuration. The experimental HOLLOTRON switch operated at parameters comparable to the scaled coaxial HOLLOTRON. However, the linear HOLLOTRON data verified the capability for meeting all the design objectives simultaneously including current density (greater than 2 A/sq cm), voltage (5 kV), switching frequency (20 kHz), switching time (300 ns), and forward voltage drop (less than or equal to 20 V). Scaling relations were determined and a preliminary design was completed for an engineering model linear HOLLOTRON switch to meet the megawatt converter system specifications. Author

N91-22503# Technische Univ., Eindhoven (Netherlands).
ON THE MODELLING OF DOWNSCALED BIPOLAR TRANSISTORS Ph.D. Thesis
Godefridus Adrianus Hurkx 1990 190 p
(ETN-91-99172) Avail: NTIS HC/MF A09

Aspects related to the modeling of currents and charges in downscaled silicon vertical n-p-n transistors are addressed. The sidewall effects on the ideal DC base and collector currents, that is the geometrical effects on the conventional ideal currents, are described. The modeling of physical phenomenon which becomes important with increasing doping density around a p-n junction, as in tunnelling in forward and reverse biased junctions, is discussed. The modeling of the AC transistor properties, a compact modeling problem related to geometrical effects, is adressed. A mathematically more rigorous low frequency description of AC currents, based on a perturbation analysis of the time dependent continuity equations, is given. ESA

N91-22504# Technische Univ., Eindhoven (Netherlands).
CATHODE SURFACE EFFECTS AND H.F.-BEHAVIOUR OF VACUUM ARCS Ph.D. Thesis
Yan Hong Fu 1990 129 p
(ISBN-90-9003766-7; ETN-91-99178) Avail: NTIS HC/MF A07

To gain a better understanding of the essential processes occurring during a vacuum arc interruption for the further development of the vacuum arc circuit breaker, cathode spot behavior, current interruption, dielectrical recovery and overvoltage generation are investigated. An experimental study on cathode spot behavior of the DC vacuum arc in relation to cathode surface roughness and a qualitative physical model to interpret the results are reported. An experimental investigation on the High Frequency (HF) current interruption, multiple recognitions and voltage escalation phenomena is reported. A calculation program to predict the level of overvoltages generated by the operation of a vacuum breaker in a realistic single phase circuit is developed. Detailed results are summarized. ESA

N91-22505# Oak Ridge National Lab., TN.
PARAMETER CORRELATION OF IMPULSE SHAPES USING TWO-PORT SYNTHESIS
J. M. Googe, P. D. Ewing, and R. A. Hess 1991 6 p Presented at the IEEE Instrumentation/Measurement Technology Conference, Atlanta, 14-16 May 1991
(Contract DE-AC05-84OR-21400)
(DE91-009121; CONF-9105135-2) Avail: NTIS HC/MF A02

Standard techniques for testing devices and systems for their response to lightning, switching transients, and electromagnetic pulse (EMP) disturbances often call for impulse shapes characterized by double exponential functions. Unfortunately, the time constants and impulse parameters such as rise time, pulse, duration, time to peak, and others are not directly related. The problem in generating test impulses is that the required standard impulses are sometimes defined by parameters and nomenclature lacking direct correlation to the desired time constants needed to derive component values for prototype impulse generator circuits. This paper derives equations for determining the time constants of the double exponential impulse from the commonly used parameters for several standard test impulses. It then proceeds to synthesize a resistor-capacitor (RC) prototype circuit that will produce the desired impulse. The prototype network is realized through a computer-aided design (CAD) procedure using Cauer's RC ladder two-port synthesis method. Descriptions of prototype circuits and test data comparing the theoretical and experimental impulse shapes are also included. The results are a simplified method for determining time constants of a double exponential function from given impulse parameters and a method for deriving the component values for prototype circuits. DOE

N91-22506# Brookhaven National Lab., Upton, NY.
EMITTANCE CORRECTION OF PHOTOCATHODE GUN
J. C. Gallardo and R. B. Palmer 1990 16 p Presented at the 12th International Free Electron Laser Conference, Paris, France, 17-21 Sep. 1990
(Contract DE-AC02-76CH-00016)
(DE91-010364; BNL-45396; CONF-9009166-21) Avail: NTIS HC/MF A03

The standard emittance calculation removes linear correlations between transverse displacement r and the divergence r(prime). Higher order correlations remain and they are responsible for a substantial area in phase space which corresponds to the calculated emittance. Time dependent correlations are identified and different procedures (transverse and longitudinal laser shaping, rf quadrulope) are proposed to remove them. The Brookhaven National Laboratory rf gun has been studied; however, in order to more clearly demonstrate the desired effects, the accelerating field and bunch length have been assumed to be more optimistic than

the present operating values. This approach reduces the realizable emittance by a factor of 5 with respect to the value before the correction. DOE

N91-22507# California Univ., Berkeley. Lawrence Berkeley Lab.
NUCLEAR MAGNETIC RESONANCE EXPERIMENTS WITH DC SQUID AMPLIFIERS Ph.D. Thesis
M. B. Heaney Nov. 1990 114 p
(Contract DE-AC03-76SF-00098)
(DE91-009775; LBL-30095) Avail: NTIS HC/MF A06

The development and fabrication of dc SQUIDs (Superconducting Quantum Interference Devices) with Nb/Al2O3/Nb Josephson junctions is described. A theory of the dc SQUID as a radio-frequency amplifier is presented, with an optimization strategy that accounts for the loading and noise contributions of the postamplifier and maximizes the signal-to-noise ratio of the total system. The high sensitivity of the dc SQUID is extended to high field NMR. A dc SQUID is used as a tuned radio-frequency amplifier to detect pulsed nuclear magnetic resonance at 32 MHz from a metal film in a 3.5 Tesla static field. A total system noise temperature of 11 K has been achieved, at a bath temperature of 4.2 K. The minimum number of nuclear Bohr magnetons observable from a free precession signal after a single pulse is about 2 x 10(exp 17) in a bandwidth of 25 kHz. In a separate experiment, a dc SQUID is used as a rf amplifier in a NQR experiment to observe a new resonance response mechanism. The net electric polarization of a NaClO3 crystal due to the precessing electric quadrupole moments of the Cl nuclei is detected at 30 MHz. The sensitivity of NMR and NQR spectrometers using dc SQUID amplifiers is compared to the sensitivity of spectrometers using conventional rf amplifiers. A SQUID-based spectrometer has a voltage sensitivity which is comparable to the best achieved by a FET-based spectrometer, at these temperatures and operating frequencies. DOE

N91-22508*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
HIGH TEMPERATURE POWER ELECTRONICS FOR SPACE
Ahmad N. Hammoud (Sverdrup Technology, Inc., Brook Park, OH.), Eric D. Baumann, Ira T. Myers, and Eric Overton 1991 8 p Presented at the First International High Temperature Electronics Conference, Albuquerque, NM, 16-20 Jun. 1991; sponsored by Sandia National Labs., AF Wright Research Development Center and New Mexico Univ.
(Contract NAS3-25266)
(NASA-TM-104375; E-6181; NAS 1.15:104375) Avail: NTIS HC/MF A02 CSCL 09C

A high temperature electronics program at NASA Lewis Research Center focuses on dielectric and insulating materials research, development and testing of high temperature power components, and integration of the developed components and devices into a demonstrable 200 C power system, such as inverter. An overview of the program and a description of the in-house high temperature facilities along with experimental data obtained on high temperature materials are presented. Author

N91-22177*# Leggett (Nickolaus), Reston, VA.
NATURAL VACUUM ELECTRONICS
Nickolaus Leggett *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 477-484 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 09C

N91-23055*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FOUR QUADRANT CONTROL OF INDUCTION MOTORS
Irving G. Hansen *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 279-286 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09A

N91-23056*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
HIGH POWER BIPOLAR LEAD-ACID BATTERIES
Gerald Halpert and Alan Attia *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 287-293 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 10C

N91-23057*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
SCIENTIFIC CCD TECHNOLOGY AT JPL
J. Janesick, S. A. Collins, and E. R. Fossum *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 294-300 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09C

34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

N91-22509*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NUMERICAL STUDIES OF CONVECTIVE COOLING FOR A LOCALLY HEATED SKIN
Stephen J. Scotti Washington May 1991 22 p
(NASA-TP-3100; L-16867; NAS 1.60:3100) Avail: NTIS HC/MF A03 CSCL 20D

A computational study of the effectiveness of tangential convective cooling for the protection of structure from intense, localized thermal loads is presented. Two dimensional numerical models of an idealized cooling problem are developed and validated. Detailed results and a parametric study of cooling effectiveness are presented for a thermal load representative of a shock-shock interaction on the engine cowl leading edge of the National Aerospace Plane (NASP). The parameters investigated are flow conditions (laminar or turbulent), coolant mass flowrate, extent of the heated region, thickness of the heated skin, and bulk properties of the coolant. The results indicate that for specific combinations of parameters, all three coolants may yield temperatures within the temperature limits of a copper alloy, NASP engine cowl leading edge. However, a liquid sodium coolant is the least sensitive of the three coolants to the assumed flow conditions and to the other parameters investigated. Author

N91-22510# Materials Research Labs., Ascot Vale (Australia).
A ONE-DIMENSIONAL FLUX-CORRECTED TRANSPORT CODE FOR DETONATION CALCULATIONS
David A. Jones, Elaine S. Oran, and Raafat Guirguis (Naval Surface Weapons Center, Silver Spring, MD.) Mar. 1991 37 p
(MRL-RR-2-90; AR-006-336) Avail: NTIS HC/MF A03

The development of a one-dimensional Flux-Corrected Transport code to model detonation in a homogeneous medium is described. The material flow is modelled using the Euler equations, and the chemical kinetics by a two-step induction parameter model which uses a quasi-steady induction time and first order Arrhenius kinetics. Two different modes of initiation are compared. Conditions necessary for a self-sustaining detonation are described and illustrated. A detailed comparison is made between the variable profiles calculated by the code and those calculated analytically using the simple Chapman-Jouguet theory and self-similar analysis, and the overall agreement is excellent. The effect of the computational cell size on these solutions is also considered. Author

N91-22511# Aeronautical Research Labs., Melbourne (Australia).
WATER TUNNEL FLOW VISUALISATION OF VORTEX BREAKDOWN OVER THE F/A-18
D. H. Thompson Dec. 1990 64 p
(ARL-Flight-Mech-R-179; AR-005-607) Copyright Avail: NTIS HC/MF A04

Vortex flow patterns over models of the F/A-18 aircraft were visualized using dye and hydrogen bubble techniques in a water tunnel. The axial position of vortex breakdown in the leading-edge extension (LEX) vortices was measured, and was found to be insensitive to Reynolds number, to flap setting, and to small variations in model cross-section shape. Engine inlet flow did alter the vortex breakdown position, at flow rates that might be encountered under flight conditions. The fitting of fences on the LEX upper surface did not affect the axial position of vortex breakdown, but did alter the vortex structure. These alterations were examined in some detail. Author

N91-22512*# MCAT Inst., San Jose, CA.
COMPUTATION OF VISCOUS BLAST WAVE FLOWFIELDS
Final Report, 1 Jun. 1988 - 31 May 1990
Christopher A. Atwood Mar. 1991 27 p
(Contract NCC2-540)
(NASA-CR-188080; NAS 1.26:188080) Avail: NTIS HC/MF A03 CSCL 20D

A method to determine unsteady solutions of the Navier-Stokes equations was developed and applied. The structural finite-volume, approximately factored implicit scheme uses Newton subiterations to obtain the spatially and temporally second-order accurate time history of the interaction of blast-waves with stationary targets. The inviscid flux is evaluated using MacCormack's modified Steger-Warming flux or Roe flux difference splittings with total variation diminishing limiters, while the viscous flux is computed using central differences. The use of implicit boundary conditions in conjunction with a telescoping in time and space method permitted solutions to this strongly unsteady class of problems. Comparisons of numerical, analytical, and experimental results were made in two and three dimensions. These comparisons revealed accurate wave speed resolution with nonoscillatory discontinuity capturing. The purpose of this effort was to address the three-dimensional, viscous blast-wave problem. Test cases were undertaken to reveal these methods' weaknesses in three regimes: (1) viscous-dominated flow; (2) complex unsteady flow; and (3) three-dimensional flow. Comparisons of these computations to analytic and experimental results provided initial validation of the resultant code. Addition details on the numerical method and on the validation can be found in the appendix. Presently, the code is capable of single zone computations with selection of any permutation of solid wall or flow-through boundaries. Author

N91-22513*# Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics.
RADIATIVE INTERACTIONS IN LAMINAR DUCT FLOWS
Progress Report, Jan. 1988 - Aug. 1990
P. A. Trivedi and S. N. Tiwari Dec. 1990 122 p
(Grant NAG1-363)
(NASA-CR-188150; NAS 1.26:188150; ODU/ICAM-90-101)
Avail: NTIS HC/MF A06 CSCL 20D

Analyses and numerical procedures are presented for infrared radiative energy transfer in gases when other modes of energy transfer occur simultaneously. Two types of geometries are considered, a parallel plate duct and a circular duct. Fully developed laminar incompressible flows of absorbing-emitting species in black surfaced ducts are considered under the conditions of uniform wall heat flux. The participating species considered are OH, CO, CO2, and H2O. Nongray as well as gray formulations are developed for both geometries. Appropriate limiting solutions of the governing equations are obtained and conduction-radiation interaction parameters are evaluated. Tien and Lowder's wide band model correlation was used in nongray formulation. Numerical procedures are presented to solve the integro-differential equations for both geometries. The range of physical variables considered are 300 to 2000 K for temperature, 0.1 to 100.0 atm for pressure, and 0.1 to 100 cm spacings between plates/radius of the tube. An extensive parametric study based on nongray formulation is presented. Results obtained for different flow conditions indicate that the radiative interactions can be quite significant in fully developed incompressible flows. Author

N91-22514 Minnesota Univ., Minneapolis.
TOPICS IN THE FLUID MECHANICS OF VISCOELASTIC LIQUIDS Ph.D. Thesis
Claude Verdier 1990 121 p
Avail: Univ. Microfilms Order No. DA9100988

The behavior of some viscoelastic fluids was studied mathematically. As in transonic flows with the potential function, some fluids can undergo a change of type in the vorticity equation, and this gives rise to shocks in the first derivatives of the velocity components. These properties were recently shown to explain some unusual phenomena. Special flows for which similarity solutions exist are studied, and it is found that basic solutions can undergo a change of type in the vorticity equation. This is something that has not been shown before, because only perturbed flows of viscoelastic fluids have been studied. Particular attention is paid to the nonlinear model of White-Metzner. This model is found to become even more hyperbolic than the usual Maxwell models. Also, well posedness, i.e., stability due to short waves, is analyzed. This notion is very important since this kind of instability can lead to catastrophic behavior of numerical solutions. Conditions for well posedness are obtained. Also, the K-BKZ model is studied for which similar results are obtained. It is shown that the structure of this model is comparable to the White-Metzner's model. Finally, experimental measurements of interfacial tension between polymer melts at high temperatures are carried out. The technique of the spinning drop tensiometer, which consists of spinning a small amount of one fluid inside another one, is adapted until a steady shape is obtained. When the rotational speed is high enough, the shape of the inner fluid is a long cylinder with rounded ends. Then one can simply determine interfacial tension from the shape of the fluid. Careful measurements are done here for standard polymers. Dissert. Abstr.

N91-22515 State Univ. of New York, Buffalo.
EFFECT OF STRONG CRITICAL LAYER NONLINEARITY ON THE SPATIAL EVOLUTION OF EXTERNALLY EXCITED COMPRESSIBLE FREE SHEAR LAYERS Ph.D. Thesis
David William Wundrow 1990 99 p
Avail: Univ. Microfilms Order No. DA9033751

The nonlinear evolution of a spatially growing two-dimensional disturbance on a compressible shear layer between two parallel streams is considered. The disturbance is assumed to evolve from a strictly linear finite growth rate instability wave with nonlinear effects first becoming important in the critical layer. The mean temperature profile is assumed to have a local maximum near the critical level in order to account for the effect of viscous dissipation. The mean temperature gradient at the critical level and the local Reynolds number are taken to be just small enough so that the critical layer is strongly nonlinear and viscous (i.e., the spatial evolution, transverse convection, and viscous diffusion terms appearing in the equations that govern the flow in the critical layer are all of the same order of magnitude). A combination of multiple scales method and boundary layer theory is used to obtain asymptotic expansions for the perturbed flow inside and outside the critical layer. The nonlinear evolution of the instability wave is then determined by matching these inner and outer expansions. The numerical solution to the resulting equations is worked out and discussed in some detail. The results show that the critical layer nonlinearity converts the exponential growth of the instability wave to a weak, apparently algebraic, growth well upstream of the neutral stability point. Dissert. Abstr.

N91-22516 Catholic Univ. of America, Washington, DC.
AN EXPERIMENTAL INVESTIGATION OF VELOCITY FIELD AND WALL PRESSURE FLUCTUATIONS IN TURBULENT

FLOWS Ph.D. Thesis
Hassan M. S. Helal 1990 218 p
Avail: Univ. Microfilms Order No. DA9027614

The objective of the investigation was to better understand the mechanisms by which turbulent boundary layer (TBL) flows produce wall pressure fluctuations. The approach was to study the velocity field above a smooth flat plate The experiments were conducted in a low noise specially designed wind tunnel facility for velocities ranging from 15.3 to 27.3 m/sec. Pinhole microphones were used to measure wall pressure fluctuations. Velocity data were obtained using both a single and an x-wire anemometer at several downstream locations. Spectral analysis was used as a major tool in determining both velocity field and wall pressure characteristics. Two methods were used to identify wall pressure sources in the turbulent structure over the solid surface. The measured velocity field confirmed the existence of a fully developed equilibrium TBL that conforms with the generally accepted criteria. Velocity spectra showed the existence of a bulge region outside the boundary layer where the flow is irrotational. Velocity statistics across the TBL in the from of a probability density function revealed the existence of an intermittent structure. Wall pressure spectra measurements displayed the features that characterize the equilibrium TBL. The scaling of the wall pressure spectra on the flow variables was utilized as an indirect method of source identification. The inner variables successfully collapsed the high frequency wall pressure spectra. A wall pressure probability density function was used to compute wall pressure statistics revealing its characteristics. Dissert. Abstr.

N91-22517 Warwick Univ., Coventry (England).
CONVECTIVE INSTABILITIES IN BINARY FLUIDS Ph.D. Thesis
David Holton 1989 146 p
Avail: Univ. Microfilms Order No. BRD-90930

The subject of two-dimensional convection in a binary fluid is treated by analytical methods and through Galerkin models. The analysis is focussed on describing the dynamics of convection at onset of convection. Two independent dynamical parameters are present - one more degree of freedom than single fluid convection. Normal forms are derived for the tricritical bifurcation - describing the transition between a forward and backward pitchfork bifurcation of a two-dimensional array of rolls in a convecting bulk binary fluid mixture. A multiple time perturbation scheme is constructed to fifth order to describe this motion. The coefficients of the equation are determined as a function of the Lewis number (the ratio of the mass to thermal diffusivity). The degenerate Hopf bifurcation is also investigated using a similar perturbative scheme; with a prediction of the coefficients involved. Dissert. Abstr.

N91-22518 Idaho Univ., Moscow.
INVESTIGATION OF THE ONSET AND DEVELOPMENT OF VORTEX STREETS IN STEADY AND UNSTEADY FLOWS Ph.D. Thesis
Timothy Hsichyin Lee 1990 190 p
Avail: Univ. Microfilms Order No. DA9102198

The stability of the wake behind a circular cylinder in both steady and unsteady flows is investigated. End plate effects on vortex shedding modes in steady flow are examined by flow visualization. The influence of time-dependent flow on the stability and limit cycle behavior of circular cylinder wakes is investigated by hot-wire anemometry. Vortex shedding frequencies, mean wake parameters, and critical Reynolds numbers of the laminar wake are measured in a uniform freestream over a circular cylinder with end plates. Unsteady flow investigations include: (1) the development of the attached vortices just before the transition; (2) the onset and the growth of the two-dimensional vortex street to the flow speed changes; (3) the frequency of the limit cycle vortex streets, and (4) the response of the established two-dimensional vortex street to the flow speed changes. The combined stabilizing effects of end plates along with the applied flow acceleration are also considered. For cylinder length-to-diameter ratios less than 43, the results of the steady flow experiments show that parallel shedding is generated and that the stability of the wake is quadratically related to the distance between the end plates. The parallel shedding mode is also observed when end plates are replaced by end cylinders. In unsteady flow, it is found that the stability of the wake is exponentially related to the magnitude of the flow acceleration. Physical models are proposed to describe the experimental observations. Dissert. Abstr.

N91-22519 Clarkson Univ., Potsdam, NY.
ON THE INSTABILITY OF LIQUID JET AND LIQUID CURTAIN Ph.D. Thesis
Zhi Wen Lian 1990 155 p
Avail: Univ. Microfilms Order No. DA9102989

The spatial instability of liquid jets and liquid curtains is investigated by using linear theory. For the case of a viscous liquid jet into an inviscid ambient gas, a unified theory is developed. It is found that the existing theories, including Rayleigh, Keller, Taylor, and Chandrasekhar's modes, are only special cases of the unified theory. Thus, this new theory would fill up the vacuum and bridge the gaps between the existing theories and be used to verify the validity range of the existing modes. The different effects of various jet flow parameters on jet stability were analysed from the computational results based on this unified theory to investigate the mechanism of jet breakup. The absolute instability of the viscous liquid jet in inviscid gas is studied, and the critical Weber number, above which the jet is absolutely unstable, is determined as a function of Reynolds number and gas to liquid density ratio. This unified theory is extended to the more general case of a viscous liquid jet injected into a swirling ambient gas, it is found that the gas swirling is a stabilizing factor while the gas density may have dual effects on the jet stability. The instability analysis of a liquid curtain in a vacuum is extended to the case of a viscous liquied curtain in an ambient gas. The participation of the ambient gas is found to change the stability of the liquid curtain both quantitatively and qualitatively. Author

N91-22520# National Aerospace Lab., Tokyo (Japan).
ANALYSIS OF LAMINAR SEPARATION BUBBLES USING A SIMPLE EDDY-VISCOSITY TURBULENCE MODEI
Kenichi Rinoie and Nobuhiko Kamiya Sep. 1990 19 p In JAPANESE; ENGLISH summary
(NAL-TR-1079; ISSN-0389-4010) Avail: NTIS HC/MF A03

Laminar separation bubbles formed on airfoils are expressed numerically using a simple eddy-viscosity turbulence model which satisfies the basic characteristics of the short bubble. The eddy viscosity constant was set to a uniform value inside the turbulent part of the bubble. Overall, characteristics of numerical results agreed closely with experimental results. The relation between the eddy viscosity constant and velocity distributions was analyzed by the momentum balance inside the bubble. It was shown that the pressure recovery inside the bubble is proportional to the eddy viscosity constant. Finally, the eddy viscosity constant is related to the non-dimensional parameter which represents the flow inside the bubble. Author

N91-22521# David Taylor Research Center, Bethesda, MD.
TRANSMISSION OF A SHOCK WAVE ACROSS AN EVACUATED BARRIER Final Report, 1 Oct. 1989 - 1 Oct. 1990
George V. Waldo, Jr. Dec. 1990 50 p
(AD-A231717; DTRC-90/038) Avail: NTIS HC/MF A03 CSCL 20/4

The transmission of a one-dimensional shock wave across an evacuated barrier in a liquid is modeled. In this model the interaction of the shock wave with the incident side of the barrier causes the liquid to cavitate. The cavitated liquid then moves across the barrier and collides with the liquid on the opposite side of the barrier, thus setting in motion a transmitted wave. The pressure history of the transmitted wave is determined from that of the incident shock wave. Although the impulse of the transmitted wave is the same as that of the incident shock wave, the transmitted wave can have considerably lower peak pressure and energy flux density. Possible extensions of this model are discussed. Also, potential military and industrial applications are considered. GRA

N91-22522# Michigan Univ., Ann Arbor. Gas Dynamics Labs.
THE INTERACTION PHENOMENA BETWEEN ADJACENT DETONATING LAYERS Final Report, 15 Jan. 1987 - 15 Jul. 1990
C. W. Kauffman and M. Sichel 15 Jan. 1991 12 p
(Contract DAAL03-87-K-0019)
(AD-A231761; ARO-24576.6-EG) Avail: NTIS HC/MF A03 CSCL 19/9

An experimental and theoretical study of the interaction which occurs when a detonation initiated in a primary explosive layer comes into contact with a bounding or secondary explosive layer was the subject of this research program. This process is of interest in connection with shaped charge design, explosive devices under consideration for clearing mine fields, and with layered explosive design to increase the efficiency of explosive energy transmission. In addition to these applications, this interaction is also of fundamental interest since interactions of this type are involved in the diffraction of detonations, the propagation of detonations over obstacles, and the transition from deflagration of detonation. It also has been found that layered gaseous explosives can be used to generate oblique detonation waves which are of interest in connection with oblique detonation ram jets, and hypervelocity accelerators. The interaction between the explosive layers has been simulated numerically using the Flux Corrected Transport (FCT) algorithm. The simulation produced pressure, temperature, density and reactant contours throughout the interaction region as well as the pressure signature on the walls bounding the interaction region which were in excellent qualitative agreement with the experiments. GRA

N91-22523# University of Southern California, Los Angeles. Dept. of Aerospace Engineering.
UNSTEADY BEHAVIOR OF TURBULENT SHEAR FLOWS Final Technical Report, 1 May 1985 - 30 Apr. 1990
Chih-Ming Ho, P. Huerre, and L. G. Redekopp 25 Jul. 1990 29 p
(Contract F49620-85-C-0080)
(AD-A231836; AFOSR-91-0010TR) Avail: NTIS HC/MF A03 CSCL 20/4

Theoretical studies on the temporal and spatial structure in blunt body wakes have revealed the necessary conditions under which global, self-sustained oscillations appear and have provided firm criteria for specifying the frequency of these oscillations. The theory has also been employed to describe the preferred mode in jets. In addition, a theoretical description of the appearance of the spatial chaos in wake-shear layers, and its representation in terms of a one-dimensional map, has been provided. An experimental facility and necessary instrumentation have been assembled, and experiments are in progress on spatial chaos in wake-shear layers. Preliminary results have revealed a parameter domain where a temporal vacillation occurs between the Karman wake mode and the shear layer mode. GRA

N91-22524*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SECOND ORDER MODELING OF BOUNDARY-FREE TURBULENT SHEAR FLOWS
T.-H. Shih, Y.-Y. Chen, and J. L. Lumley (Cornell Univ., Ithaca, NY.) May 1991 17 p
(NASA Order C-99066-G)
(NASA-TM-104369; ICOMP-91-07; E-6170; NAS 1.15:104369; CMOTT-91-02) Avail: NTIS HC/MF A03 CSCL 20D

A set of realizable second order models for boundary-free turbulent flows is presented. The constraints on second order models based on the realizability principle are re-examined. The rapid terms in the pressure correlations for both the Reynolds stress and the passive scalar flux equations are constructed to exactly satisfy the joint realizability. All other model terms (return-to-isotropy, third moments, and terms in the dissipation equations) already satisfy realizability. To correct the spreading rate of the axisymmetric jet, an extra term is added to the dissipation equation which accounts for the effect of mean vortex stretching on dissipation. The test flows used in this study are the mixing shear layer, plane jet, axisymmetric jet, and plane wake. The numerical solutions show that the unified model equations predict all these flows reasonably. It is expected that these models would be suitable for more complex and critical flows. Author

N91-22525# Technische Univ., Eindhoven (Netherlands).
FLOW OF DILUTE EMULSIONS THROUGH POROUS MEDIA Ph.D. Thesis
Johannes Anna Maria Hofman 1990 135 p Sponsored by Koninklijke/Shell Exploraten Produktielab., and Netherlands Foundation for Technical Research
(ETN-91-99167) Avail: NTIS HC/MF A07

The transport of dilute stable oil in water emulsions through packed beds of glass beads is described. Results of measurements performed to describe the stability of the emulsions used before the flow experiments could be carried out are described. Experiments to study the transport of the emulsions through porous media are described. A microscopic model which describes the interaction of a single emulsion droplet with the porous material near a pore constriction is presented. The properties of the oil-water interface being very important, some preliminary experiments for measuring the interfacial viscosity are described. It is too early to include this data in the subject but it is included as a starting point for future work. ESA

N91-22526# Bristol Univ. (England). Dept. of Aerospace Engineering.
AN INVESTIGATION INTO THE SHEAR STRENGTH OF ICE B.S. Thesis
Meredith C. W. Evans and John R. Moore Jun. 1990 35 p
(BU-501; ETN-91-99194) Avail: NTIS HC/MF A03

For future cryogenic fuelled aircraft, employing an intake heat exchanger, icing of the heat exchanger could be a problem. Previous work suggested that on copper at low temperatures, the shear strength of ice reaches zero. Thus the shear strength of ice adhered to various metal and non metal, slightly roughened, plate surfaces was investigated in the temperature range from 0 C until the bond shear strength reached zero. The water drops being initially placed on and removed with the plate temperature constant. Later drops were placed with the plate at 0 C and then cooled to the required temperature. Finally, photographs were taken of the regions from which the drops were removed. It was found that water droplets would not remain adhered to the surface of a metal heat exchanger. It was also found that for common application and removal temperature, for metals, at any temperature below a given point, the shear strength is a linear function of the difference in linear expansivities of ice and the metal. At temperatures above this critical point, the shear strength is dependent on the strength of the interface layer between the ice and plate material. ESA

N91-22527# Bristol Univ. (England). Dept. of Aerospace Engineering.
AN EXPERIMENTAL INVESTIGATION INTO FIN/BULB KEELS FOR THE PORT PENDENNIS AMERICA'S CUP CHALLENGE B.S. Thesis
Ian S. Meakin and Nicola M. Thompson Jun. 1990 44 p
(BU-511; ETN-91-99204) Avail: NTIS HC/MF A03

Three fin/bulb keel models were investigated in a wind tunnel to find their overall flow characteristics using standard methods of flow visualization. A canard rudder was placed forward of the keels to determine the effect of its trailing vortex on the keels. At all incidences tested, the flow characteristics of the keels were found to be similar. These similarities included fin separation bubbles and open separation on the bulbs. The rudder's interference effects on the keels were dependent on its position and hence whether its trailing vortex touched or flowed past the keels. ESA

N91-22528# Bristol Univ. (England). Dept. of Aerospace Engineering.
FLOW INVESTIGATION OF A GROUND EFFECT VEHICLE B.S.

Thesis
C. C. V. Salmon and S. G. Thompson Jun. 1990 48 p
(BU-516; ETN-91-99209) Avail: NTIS HC/MF A03

Quantitative and qualitative tests were performed on a proposed tricycle lifting jet configured delta aircraft, operating in ground effect, to determine the flow characteristics, jet stability and pressure forces on the underside of the vehicle. For jet speeds of 200 ft/s and 300 ft/s, and a range of forward speeds, the jet stability at heights above the ground plane ranging from 0.14 S to 0.51 S were investigated, where S is the span of the model. Instability of the jet system occurred where the jets tucked under the model, and this was recorded as a critical forward speed. In addition, the effects of both positive and negative incidence changes and forward inclination of the front jet, were investigated. Plots of the ratio critical forward speed/jet speed with height were produced, along with lift performance curves, for the above flight variables. At zero forward speed, clear peaks were noted in lift performance at a vehicle height of approximately 0.35 S, for both jet speeds. This was modified by incidence and jet inclination, the maximum lift decreasing in both cases. Pressure distributions and wool tuft flow visualization on the underside of the model led to the determination of local flow pattern characteristics. Normal pressure forces and pitch stability for hovering and transitional flight were investigated. Regions of jet impingement from the reflected 'lifting jets' and jet entrainment, were clearly seen and monitored for varying flight conditions. ESA

N91-22529# Bristol Univ. (England). Dept. of Aerospace Engineering.
THE USE OF AXISYMMETRIC FLOW FOR INVESTIGATION OF SHOCK WAVE-BOUNDARY LAYER INTERACTIONS B.S. Thesis
C. K. Tunbridge and A. C. Youngs Jun. 1990 39 p
(BU-520; ETN-91-99213) Avail: NTIS HC/MF A03

An experimental rig was designed and manufactured to enable the study of one particular situation of shock wave boundary layer interaction. The concept of axisymmetry was used to create a pseudo 2-D flow situation, thus alleviating the problem of side wall effects. Important design parameters were: a Mach number of 2; Reynolds number range of 250,000 to 450,000; working section diameter of 80 mm (approx). The required supersonic nozzle was obtained by scaling from an existing design. Detailed information regarding this method is included. Time constaints restricted testing to rig calibration and the implementation of associated instrumentation. Further specialized instrumentation was designed and manufactured, but not tested. Uniform Mach 2 supersonic flow was achieved but with slight concession to some of the design specifications. This was due to problems with maintaining a sufficiently low downstream pressure while running the rig. The success of the project is reviewed, and recommendations for further work required for the full operation of the tunnel are made. ESA

N91-22530# Universitaet der Bundeswehr Muenchen, Neubiberg (Germany, F.R.). Inst. fuer Raumfahrttechnik.
AXIAL RESPONSE OF AN AMPHORA-TYPE LIQUID COLUMN
Helmut F. Bauer and Werner Eidel 1990 29 p
(LRT-WE-9-FB-2(1990); ETN-91-99245) Avail: NTIS HC/MF A03

Under axial microgravity an originally circular cylindrical liquid column assumes an amphora type geometry. The response of an axially excited amphora type liquid column consisting of nonviscous liquid is investigated for a harmonic excitation. Free surface displacement and velocity response are determined. The results will be used for the efficient planning of the LICORE (Liquid Columns Resonance) experiments in the second German Spacelab mission (D2). ESA

N91-22531# Universitaet der Bundeswehr Muenchen, Neubiberg (Germany, F.R.). Inst. fuer Raumfahrttechnik.
NATURAL FREQUENCIES OF A SPININNG AMPHORA-TYPE LIQUID COLUMN
Helmut F. Bauer and Werner Eidel 1990 59 p
(LRT-WE-9-FB-5(1990); ETN-91-99246) Avail: NTIS HC/MF A04

The vibration of cylindrical liquid columns are of interest in zero gravity manufacturing processes. If the temperature gradient in axial direction yields Marangoni convection, which may become oscillatory at a critical Marangoni number, an effect detrimental to the process, rotation of the liquid column, will supress those oscillations. It is therefore of importance to know the vibrational behavior of a rotating liquid bridge. The natural frequencies of a solidly rotating finite amphora type column consisting of a frictionless liquid are determined. According to the magnitude Omega(sub 0) of the spin, natural frequencies in the elliptic (omega greater than 2 Omega(sub 0)) and hyperbolic frequency range (omega less than 2 Omega(sub 0)) must be distinguished. The basic equations and their solution are given and results concluded. ESA

N91-22532# Universitaet der Bundeswehr Muenchen, Neubiberg (Germany, F.R.). Inst. fuer Raumfahrttechnik.
RESPONSE OF A VISCOUS LIQUID LAYER AROUND A CENTER-CORE AXIAL EXCITATION IN ZERO-GRAVITY
Helmut F. Bauer 1990 85 p
(LRT-WE-9-FB-9(1990); ETN-91-99248) Avail: NTIS HC/MF A05

The response of a viscous liquid layer around a center core to axial excitation is determined analytically. For a simplified analytical treatment the no slip condition at the top and the bottom of the liquid column had to be abandoned while the normal condition could be satisfied. The free liquid surface elevation and the radial and axial velocity distributions are presented for various surface tension parameters, aspect ratios, and at various locations inside and along the liquid bridge as function of the forcing frequency parameter. It could be noticed that due to viscosity the resonance amplitudes are finite and that the lowest resonance is sharply tuned. ESA

N91-22533# Alabama Univ., Huntsville. Center for Microgravity and Materials Research.
A FOURIER-CHEBYSHEV PSEUDOSPECTRAL METHOD FOR SOLVING STEADY 3-D NAVIER-STOKES EQUATIONS IN CYLINDRICAL CAVITIES
J. P. Pulicani and J. Ouazzani 1991 33 p
Avail: NTIS HC/MF A03

A Fourier-Chebyshev pseudospectral method for solving steady 3D Navier-Stokes equations in cylindrical cavities is presented and discussed. The general method is pseudo-unsteady and uses a semi-implicit finite difference scheme for the time discretization. The generalized ADI (Alternating Direction Implicit) procedure is then applied to reduce the problem to a successive solution of one dimensional problems. The spatial approximation uses a Fourier-Galerkin approximation in the periodic direction and a Chebyshev-collocation approximation in the other directions. Difficulties related to the pressure are surmounted by using the artificial compressibility method. A suitable variable change was chosen to avoid the problem of singularity at the axis generated by cylindrical coordinates. The method is first tested on an advection-diffusion equation and then on the Navier-Stokes equations. Finally, the method is illustrated by a convection problem of a differentially heated fluid. Author

N91-22534# Lawrence Livermore National Lab., CA.
DESIGN CALCULATIONS FOR THE MICROCHANNEL HEATSINK
R. A. Riddle, R. J. Contolini, and A. F. Bernhardt 15 Jan. 1991 12 p Presented at the National Electronics Products Conference (NEPCON), Anaheim, Feb. 1991
(Contract W-7405-eng-48)
(DE91-008730; UCRL-JC-105120; CONF-910292-1) Avail: NTIS HC/MF A03

The microchannel heatsink (MCHS) has been shown to be a very compact, effective heat transfer structure. It has the capability to provide cooling for high speed computer chips, laser diodes

arrays, radio and microwave frequency amplifiers and other high power electronic devices. As an example of its capability a 1 kW/sq cm heat dissipation has been obtained with a 100 C temperature differential between the active device surface and the water coolant. In order to understand and predict the thermal performance of the MCHS using various power devices, different coolants, and structural configurations a computer program MCHSCALC has been written. This program has been verified by comparison to experimental data. DOE

N91-22535# Cornell Univ., Ithaca, NY.
THEORY AND SIMULATION OF FLUIDS OF ASSOCIATED CHAIN MOLECULES
Nov. 1990 5 p
(Contract DE-FG02-88ER-13974)
(DE91-009873; DOE/ER-13974/T1) Avail: NTIS HC/MF A01

During the past year we have continued our research on associating fluids and their mixtures, and have also initiated work on the behavior of fluids in small pores. We have successfully applied the new theoretical equation of state to a variety of pure liquids, including liquids of chain molecules up to decane, as well as a variety of associating liquids. Excellent results have been obtained for water, acetone, methanol, acetic acid, and nitric oxide. In parallel with this work we have been pursuing a program to make the theoretical equation more accurate and particularly to extend it to longer chains. We have begun a comprehensive study of the type of adsorption isotherms, layering and capillary transitions, and hysteresis effects that can be observed in Lennard-Jones fluids in pores of cylindrical and slit geometries, using a combination of density functional theory and molecular simulation techniques. DOE

N91-22536*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CHARACTERISTICS OF 3D TURBULENT JETS IN CROSSFLOW
A. O. Demuren Apr. 1991 22 p
(NASA Order C-99066-G)
(NASA-TM-104337; ICOMP-91-05; E-6106; NAS 1.15:104337)
Avail: NTIS HC/MF A03 CSCL 20D

Three dimensional turbulent jets in crossflow at low to medium jet-to-crossflow velocity ratios are computed with a finite volume numerical procedure which utilizes a second-moment closure model to approximate the Reynolds stresses. A multigrid method is used to accelerate the convergence rate of the procedure. Comparison of the computations to measured data show good qualitative agreement. All trends are correctly predicted, though there is some uncertainty on the height of penetration of the jet. The evolution of the vorticity field is used to explore the jet-crossflow interaction. Author

N91-22537*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
IGNITION AND STRUCTURE OF A LAMINAR DIFFUSION FLAME IN A COMPRESSIBLE MIXING LAYER WITH FINITE RATE CHEMISTRY Final Report
C. E. Grosch and T. L. Jackson (Old Dominion Univ., Norfolk, VA.) Apr. 1991 29 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-187551; NAS 1.26:187551; ICASE-91-35) Avail: NTIS HC/MF A03 CSCL 20D

The ignition and structure of a reacting compressible mixing layer is considered using finite rate chemistry lying between two streams of reactants with different freestream speeds and temperatures. Numerical integration of the governing equations show that the structure of the reacting flow can be quite complicated depending on the magnitude of the Zeldovich number. An analysis of both the ignition a diffusion flame regimes is presented using a combination of large Zeldovich number asymptotics and numerics. This allows to analyze the behavior of these regimes as a function of the parameters of the problem. Author

N91-23024*# Sterling Federal Systems, Inc., Palo Alto, CA.
FAST: A MULTI-PROCESSED ENVIRONMENT FOR VISUALIZATION OF COMPUTATIONAL FLUID
Gordon V. Bancroft, Fergus J. Merritt, Todd C. Plessel, Paul G. Kelaita, R. Kevin McCabe, and Al Globus *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 21-30 (For primary document see N91-23021 14-99)
(Contract NAS2-11555)
Avail: NTIS HC/MF A18 CSCL 20D

N91-23058*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
ADVANCED THERMAL CONTROL TECHNOLOGY FOR COMMERCIAL APPLICATIONS
Theodore D. Swanson *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 301-306 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 20D

35 INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources and Remote Sensing.* For related information see also *06 Aircraft Instrumentation,* and *19 Spacecraft Instrumentation.*

N91-22538*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LOW-ENERGY POSITRON FLUX GENERATOR FOR MICROSTRUCTURAL CHARACTERIZATION OF THIN FILMS
Jag J. Singh, Abe Eftekhari (Analytical Services and Materials, Inc., Hampton, VA.), and Terry L. St.Clair Washington May 1991 19 p
(NASA-TP-3074; L-16881; NAS 1.60:3074) Avail: NTIS HC/MF A03 CSCL 14B

A slow positron flux generator using well annealed polycrystalline tungsten moderators and a Na-22 positron source was developed for microstructural characterization of thin insulator (ceramics and polymeric) films. A 250 micro-c source, deposited on a 2.55 x 10 (exp -4) cm thick aluminized mylar film, is sandwiched between two 0.0127 cm thick, 2.54 x 2.54 cm tungsten strips. Two 2.54 x 2.54 cm test insulator films, whose thicknesses may range from 0.00127 to 0.0127 cm, insulate the two tungsten moderator strips from the aluminized mylar source holder. A potential difference of 10 to 100 volts, depending on the test insulator film thickness, is applied between the tungsten strips and the source holder. Thermalized positrons diffusing out of the moderator strips are attracted to the source holder when it is at a negative potential. These positrons have to drift through the test insulator films in order to reach the source holder. On the other hand, they are prevented from entering the test films when the source holder is at a positive potential. The difference between the positron lifetime spectrum with the source at + or - volts is thus expected to provide the test film lifetime spectrum. Author

N91-22539# National Inst. of Standards and Technology, Boulder, CO. Time and Frequency Div.
CHARACTERIZATION OF CLOCKS AND OSCILLATORS
Donald B. Sullivan, ed., David W. Allan, ed., David A. Howe, ed., and Fred L. Walls, ed. Mar. 1990 354 p
(PB91-100909; NIST/TN-1337) Avail: NTIS HC/MF A16 CSCL 14B

A collection of published papers is presented assembled as a reference for those involved in characterizing and specifying high-performance clocks and oscillators. Tutorial papers, papers on standards and definitions, and a collection of papers detailing specific measurements and analysis techniques are included. The discussion in the introduction to the volume provides a guide to

the content of the papers, and tables and graphs provide further help in organizing methods described in the papers. Author

N91-22540*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A SYNCHRONOUS STROBED LASER LIGHT SHEET FOR ROTOR FLOW VISUALIZATION
Bradley D. Leighty, David B. Rhodes, John M. Franke, and Stephen B. Jones Washington May 1991 19 p Presented at the 36th International Instrumentation Symposium, Denver, CO, 6 May 1990 Previously announced in IAA as A91-24979
(NASA-TM-4266; L-16877; NAS 1.15:4266) Avail: NTIS HC/MF A03 CSCL 14B

A synchronous strobed laser light sheet generator was designed and used for flow visualization of a helicopter rotor model. The laser light sheet strobe circuit was designed to allow selectable blade position viewing, strobe duration, and multiple pulses per revolution for rotors having 2 to 9 blades. A slip-sync mode permits slow motion visualization of the flow field over complete rotations of the rotor. The design was tested at NASA Langley Research Center's 14 by 22 foot subsonic tunnel where the flow was seeded with propylene glycol smoke. Between runs, a calibration grid board was placed in the plane of the laser sheet and recorded with the video camera at the position used to record the flow field. The system was used to make 2-dimensional flow field cuts of a four-bladed rotor operating at wind tunnel speeds up to 79.25 meters per second (260 feet per second). Author

N91-22541*# Hughes Aircraft Co., Los Angeles, CA. Space and Communications Group.
HIGH RESOLUTION MICROWAVE SPECTROMETER SOUNDER (HIMSS), VOLUME 1, BOOK 2 Final Report
Oct. 1990 370 p
(Contract NAS8-38175)
(NASA-CR-184130-Vol-1-Bk-2; NAS 1.26:184130-Vol-1-Bk-2; HS256C-1045-0061) Avail: NTIS HC/MF A16 CSCL 14B

The following topics are presented with respect to the high resolution microwave spectrometer sounder (HIMSS) that is to be used as an instrument for NASA's Earth Observing System (EOS): (1) preliminary program plans; (2) contract end item (CEI) specification; and (3) the instrument interface description document. Under the preliminary program plans section, plans dealing with the following subject areas are discussed: spares, performance assurance, configuration management, software implementation, contamination, calibration management, and verification. K.S.

N91-22542*# Hughes Aircraft Co., Los Angeles, CA. Space and Communications Group.
HIGH RESOLUTION MICROWAVE SPECTROMETER SOUNDER (HIMSS), VOLUME 1, BOOK 1 Final Report
Oct. 1990 106 p
(Contract NAS8-38175)
(NASA-CR-184129-Vol-1-Bk-1; NAS 1.26:184129-Vol-1-Bk-1; HS256C-1045-0061) Avail: NTIS HC/MF A06 CSCL 14B

The following topics are presented with respect to the high resolution microwave spectrometer sounder (HIMSS) that is to be used as an instrument for NASA's Earth Observing System (EOS): (1) an instrument overview; (2) an instrument description; (3) the instrument's conceptual design; (4) technical risks and offsets; (5) instrument reliability; (6) commands and telemetry; (7) mass and power budgets; (8) integration and test program; (9) program implementation; and (10) phase CD schedule. K.S.

N91-22543# Giannotti and Associates, Inc., Annapolis, MD.
DEVELOPMENT OF AN ONBOARD STRAIN RECORDER Final Report
Eric Green and William A. Wood 1990 120 p
(Contract DTCG23-85-C-20071)
(AD-A231908; SR-1303; SSC-344) Avail: NTIS HC/MF A06 CSCL 13/10

The data requirements for a standard strain recorder are developed to obtain ship structural response data for a number of applications. A review of the state of the art in strain recording instrumentation is presented and compared to the ideal instrumentation. A specific standard strain recorder is capable of recording ship structural response data resulting from severe environments facilitating validation of load criteria and analysis for ship structural response. GRA

N91-22544# RDP, Inc., Waltham, MA.
VISUAL PHOTOMETRIC EXPERIMENT DATA ANALYSIS Report, 23 Jan. 1987 - 31 Jan. 1990
Andrew J. Mzaaella, Jr. and Kevin P. Larson 30 Jul. 1990 26 p
(Contract F19628-87-C-0065)
(AD-A231915; GL-TR-90-0222; SR-4) Avail: NTIS HC/MF A03 CSCL 17/7

The Visual Photometric Experiment (VIPER) is an instrument package designed for a shuttle-borne Get-Away Special canister. Data processing and analysis developments for the VIPER are described, including support for the camera and visual radiometer processing, pre-flight laboratory calibration, and development of the star field matching algorithm for the post flight pointing determination. GRA

N91-22545# Naval Ocean Systems Center, San Diego, CA.
CHARACTERIZING AND IMPROVING THE PERFORMANCE OF THE MVDR PROCESSOR Final Report
M. Reuter Nov. 1990 81 p
(AD-A231928; NOSC/TD-1983) Avail: NTIS HC/MF A05 CSCL 09/1

In this document we demonstrate the utility of the magnitude squared of the minimum variance distortionless response (MVDR) weight vector and the performance improvement due to adaptivity (PIA) in characterizing MVDR performance. We use these parameters to determine how and under what conditions MVDR performance is degraded due to various environmental conditions. We also use these parameters as a basis for improving MVDR performance. We will confuse ourselves to the plane wave signal model in this document to concentrate on the issues of adaptive array processing and to separate the analysis from the more general matched field problem. Thus, the simulations presented here will involve only sparse, horizontal random arrays. In section 1.0 we introduce basic array processing principles. In section 2.0 we describe these useful parameters and show under what conditions MVDR performance is enhanced or degraded. In section 3.0 we present and analyze approaches to improving MVDR performance that are based upon synthetic alterations of the environment. Finally in section 4.0 we present MVDR processor simulation results that demonstrate the effect various environmental conditions have on performance and how the white noise constraint (WNC) robust MVDR algorithm can improve MVDR performance under conditions of mismatch. GRA

N91-22546# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
CONSTRUCTION OF THE ZEUS FORWARD/REAR CALORIMETER MODULES AT NIKHEF
R. Blankers, J. Engelen, H. Geerinck, J. Homma, P. Hunck, N. deKoning, P. Kooijman, A. Korporaal, R. Loos, and J. Straver et al Jul. 1990 55 p
(NIKHEF-H/90-11; ETN-91-99126) Avail: NTIS HC/MF A04

The design and assembly procedure of the FCAL/RCAL (Forward (in proton direction) Calorimeter/Rear (in electron direction) Calorimeter) of the Zeus detector to study electron proton interactions at Desy, Hamburg (Germany, F.R.) are detailed. The main components of the modules are described: steel C-frame which provides the overall mechanical module structure; a stack of depleted uranium plates and scintillator plates; wavelength shifter material, mounted in cassettes for the readout of the scintillator light; stainless steel straps which compress the stack and fix it to the C-frame. Finite element techniques for module force calculations are outlined. The module assembly and transport and calibration tools are described. ESA

N91-22547# Beleidscommissie Remote Sensing, Delft (Netherlands).
INVESTIGATION OF A THERMAL INFRARED DETECTOR ARRAY [ONDERZOEK AAN EEN THERMISCH INFRAROOD DETECTOR ARRAY]
H. Bokhove, H. Slot, and P. Verhoeff (Technische Physische Dienst TNO-TH, Delft, Netherlands) Dec. 1990 32 p In DUTCH (BCRS Proj. TE-1.18)
(BCRS-90-20; ETN-91-99158) Avail: NTIS HC/MF A03

An IR test setup was realized, detector electronics were designed, built and tested, and measurements were performed using a detector representative for CATS (CAESAR Airborne Thermal Scanner). It is shown that the test setup allows the necessary measurements although the chopper disc has to be improved. The tests of the electronics show that the amplifier part works well; the frequency characteristic can be improved by redimensioning, taking into account the detector resistance. The data acquisition does not work so well due to damage of multiplex circuits. The data acquisition triggering by the chopper has to be improved. The results of the measurements are promising. ESA

N91-22548# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
OPERATION OF THE MICROSTRIP GAS DETECTOR
F. Hartjes, B. Hendriksen, J. Schmitz, H. Schuijlenburg, and F. Udo Sep. 1990 23 p Presented at 2nd London Conference on Positive-Sensitive Detectors, London, England, 4-7 Sep. 1990 (NIKHEF-H/90-13; ETN-91-99219) Avail: NTIS HC/MF A03

The operation of a detector of ionizing particles using metal strips deposited on an insulating substrate to collect and amplify the electrons liberated in the counter gas is described. The study demonstrates that minimum ionizing particles can be well detected with a good accuracy. A number for the stability of the gas gain is deduced and the upper limit of the gain is discussed. A circuit to avoid damage by microdischarges is presented. ESA

N91-22549# National Oceanic and Atmospheric Administration, Boulder, CO. Climate Monitoring and Diagnostics Lab.
DOBSON SPECTROPHOTOMETER, ECC OZONESONDE, AND GROUND-BASED NOAA SBUV-2, S/N SATELLITE INSTRUMENT COMPARISON OZONE OBSERVATIONS Data Report
W. D. Komhyr, R. D. Evans, R. D. Grass, G. L. Koenig, J. A. Lathrop, and D. M. Quincy (Colorado Univ., Boulder.) Dec. 1990 23 p
(PB91-142299; NOAA-DR-ERL-CMDL-6) Avail: NTIS HC/MF A03 CSCL 14B

Dobson spectrophotometer total ozone and Umkehr and ECC ozonesonde ozone vertical distribution observations were made in Boulder, Colorado, in early April 1990 when similar observations were made quasi-simultaneously with a ground-based NOAA SBUV-2 (Solar and Backscatter UltraViolet spectrometer), SN-2, satellite ozone instrument at the Ball Corporation research and manufacturing facility in Boulder. Data obtained will be used by a team of experts from Ball Corporation and NASA in assessing their laboratory calibrations of the SBUV-2 instrument. Author

N91-22550# Spectron Development Labs., Inc., Costa Mesa, CA.
DEVELOPMENT OF AN OPTICAL VOLUMETRIC FLOWMETER Final Report, Apr. 1985 - Mar. 1989
Medhat Azzazy Sep. 1990 231 p
(Contract GRI-5084-271-0987)
(PB91-136481; SDL-89-2532-13; GRI-89/0201) Avail: NTIS HC/MF A11 CSCL 14B

The feasibility of determing the volumetric flow rate with high degree accuracy by integrating the optically measured velocity profile over the pipe cross sectional area was performed. The velocity was measured using the laser transit anemometry technique. The comparison results, of a laboratory otpical flowmeter with a Roots meter installed in series, showed that the optical flowmeter could yield highly accurate volumeteric flow rates. A 'handmade' optical volumetric flowmeter prototype based on the concept of laser transit anemometry was design and fabricated. The accuracy and precision of the prototype were tested in a laboratory wind tunnel and compared to a well-calibrated vortex meter connected in series. The accuracy of the prototype relative to the vortex meters was within + or - 0.29 percent. The center line flow velocity repeatability measured by the prototype was within + or - 0.46 percent. Field measurements of particle size and particle arrival rate in a gas pipeline were conducted. The results showed that the average particle size was 3.3 micrometers and the particle arrival rate to the prototype probe volume was few hundreds per second which is sufficient for the operation of the optical flowmeter. Optical access to the pipeline is imperative to an optical flowmeter, therefore, a field experiment to determine the rate of deposition of contaminants on the window was performed. The results show no significant deposition over 6 months. GRA

N91-23067*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Center for Space Microelectronics Technology.
ELECTRON TUNNEL SENSOR TECHNOLOGY
T. W. Kenny, S. B. Waltman, J. K. Reynolds, and W. J. Kaiser *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 370-381 Sponsored in part by DARPA (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 14B

N91-23068*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PRACTICAL APPROACHES FOR APPLICATION OF RESISTANCE TYPE STRAIN GAGES ON HIGH TEMPERATURE COMPOSITES
Thomas C. Moore, Sr. *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 382-391 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 14B

N91-23069*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
AI MASS SPECTROMETERS FOR SPACE SHUTTLE HEALTH MONITORING
F. W. Adams *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 392-399 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 14B

36 LASERS AND MASERS

Includes parametric amplifiers.
For related information see also *76 Solid-State Physics.*

N91-22551 Columbia Univ., New York, NY.
SIDEBANDS IN THE FREE ELECTRON LASER: OPTICAL GUIDING EFFECTS AND SHORT PULSES Ph.D. Thesis
James William Dodd 1990 106 p
Avail: Univ. Microfilms Order No. DA9102411

Sideband instabilities were observed on the radiation signal obtained from the Columbia Raman free electron laser at approximately 2 mm wavelengths. Evidence that optical guiding of signal radiation propagating along the electron beam slows down the radiation group velocity and shifts the sidebands away from the signal carrier is presented. In the exponential gain regime, for the case of weak or no optical guiding, the sideband shift was measured to be delta omega(sub s)/omega(sub s) = 10 +/- 2 percent, where omega(sub s) is the carrier frequency. For strong optical guiding delta omega(sub s)/omega(sub s) = 16 +/- 2 percent was measured. A 2-D waveguide code models the optical guiding effect and estimates the sideband shifts to be 6 percent for unguided and 13 percent for guided. A simplified 1-D code gives the same as 2-D without guiding; however, 1-D calculations yield a guided shift of 7.5 percent. Since the 2-D calculations more closely match the measured values, 2-D effects such as optical wave-profile modification caused by the guiding do play an

important role. For measurements at saturation as well as in a tapered undulator, sidebands shift little between the causes of strong and weak optical guiding. Calculations show that in freespace, optical guiding does persist after saturation; however, the waveguide configuration used here contributes to the disruption of the electron motion, explaining why optical guiding cannot be distinguished at saturation. A measurement of the temporal pulse width of high intensity, short duration radiation spikes (also related to the emission of strong sidebands) is made using a Young's double-slit interference technique combined with a square-law detector. The spike duration was measured to be approximately 150 +/- 50 psec, which compares favorably with an analytic theoretical model. Dissert. Abstr.

N91-22552# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
CONTROLLER DESIGN FOR A LASER STEERING MIRROR ON A FLEXIBLE STRUCTURE M.S. Thesis
Richard J. Adams 1990 57 p
(AD-A231735; AFIT/CI/CIA-90-135) Avail: NTIS HC/MF A04 CSCL 22/2

An experimental setup for disturbance rejection and pointing for a structurally borne laser beam path is explored. Motivation for the experiment is the expanding demand for structurally mounted pointing systems in space applications. The design and implementation of a disturbance rejection system is manifested in the form of a proportional-integral and feedforward controlled piezo actuated mirror. Good line-of-sight structural disturbance rejection is demonstrated for the primary transverse flexible modes of a 20 bay, 7.07 meter long, planar truss structure. A bandwidth of 60 Hz is achieved for the closed loop mirror-piezo plant. Two beam pointing systems are explored using a DC motor driven turntable to provide large scale angular movement. The actuation methods are coupled, using the turntable as a single axis gimbal for slow pointing, and the piezo-mirror in a fast disturbance rejection, fine pointing loop. Theoretical design and practical hardware considerations are explored and future research possibilities examined. GRA

N91-22553# Lowell Univ., MA.
NON-SPECULAR SCATTERING FROM ROUGHENED ALUMINUM SURFACES Interim Report, Dec. 1988 - Dec. 1990
G. Phillips, Z. Fried, and J. Waldman Nov. 1990 34 p
(Contract F19628-88-D-0020)
(AD-A231824; RADC-TR-90-301) Avail: NTIS HC/MF A03 CSCL 07/4

Scattering of CO2 laser radiation off roughened aluminum surfaces was measured and compared to the predictions of Papa, Lennon, and Taylor. The incident radiation was linearly perpendicular to the incident plane, and the scattering was analyzed along two directions, parallel, and perpendicular to the scattering plane. The experimental set up is described in detail, and data are presented for several depression and aspect angles. GRA

N91-22554# Texas Univ., Austin. Applied Research Lab.
SIGNAL PROCESSING STUDIES OF A SIMULATED LASER DOPPLER VELOCIMETRY-BASED ACOUSTIC SENSOR
Martin L. Barlett 17 Oct. 1990 71 p
(Contract N00014-89-J-1967)
(AD-A231879; ARL-TR-90-33) Avail: NTIS HC/MF A04 CSCL 17/9

In this report we discuss a possible remote acoustic sensing scheme based on laser Doppler velocimetry (LDV). The signal characteristics of an LDV signal from single particle scattering are described for differential and reference beam LDV configurations. A model is developed to simulate LDV signals which includes shot noise and random phase and additive noise contributions. Comparisons are made between results obtained from simulated and actual LDV signals using several signal processing techniques. The effects of various noise sources on LDV signal detectability and sensitivities to various optical parameters are studied using power spectral methods and a simulated LDV signal. Enhanced signal detectability in random noise backgrounds is investigated using spectral correlation methods. Results indicate that it may be possible to extend demonstrated LDV-based acoustic sensor sensitivities using higher order processing techniques.
Author (GRA)

N91-22555# Lawrence Livermore National Lab., CA.
IN-SITU SCANNED PROBE STUDIES ON SITE SPECIFICITY OF LASER SURFACE DAMAGE OF GRAPHITE, SAPPHIRE, AND MULTILAYER COATINGS
R. J. Tench, M. A. Schildbach (California Univ., Davis.), M. Balooch, W. J. Siekhaus, and A. Tesar Jan. 1991 15 p Presented at the Engineering Foundation Conference, Santa Barbara, 1-11 Jan. 1991
(Contract W-7405-eng-48)
(DE91-008568; UCRL-JC-105376; CONF-910186-1) Avail: NTIS HC/MF A03

The relationship between nm-scale surface structure and the laser-surface damage threshold is explored by exposing a sample mounted in a scanned probe microscope, and comparing the surface structure of a chosen area before and after exposure to a laser. On cleaved pyrolytic graphite, step edges damage first by exfoliation of atomic layers and recession of steps through removal of mono- or multi-layer patches. On sapphire, damage is not strongly correlated with polishing scratches, and consists of holes. These holes and the debris ejected and deposited do not predictably trigger damage by subsequent pulses. This indicates the surface structure is not likely to be the determining factor in the damage threshold of sapphire. Anti-reflective (AR) and highly-reflective (HR) coatings show predamage 'annealing.'
DOE

N91-22556# Los Alamos National Lab., NM.
FAST ITERATIVE TECHNIQUE FOR THE CALCULATION OF FREQUENCY DEPENDENT GAIN IN EXCIMER LASER AMPLIFIERS
R. C. Sze 1991 10 p Presented at the 4th Society of Photo-Optical Instrumentation Engineers (SPIE) International Symposium, Los Angeles, 20-25 Jan. 1991
(Contract W-7405-eng-36)
(DE91-009965; LA-UR-91-985; CONF-910123-20) Avail: NTIS HC/MF A02

The motivation in initiating these calculations is to allow us to observe the frequency evolution of a laser pulse as it propagates through an amplifier and then through a sequence of amplifiers. The question we seek to answer is what pulse shape do we need to produce out of a front-end oscillator so that after it propagates through the whole Aurora KrF fusion amplifier chain will result in high energy, broad-band laser fields of a given bandwidth that can be focussed onto a fusion target. The propagation of a single frequency source through an amplifier with distributed loss was considered by Rigrod and was significantly expanded by Hunter and Hunter. The latter included amplified spontaneous emission OASEE considerations both in the direction of and transverse to the coherent field. Analytic solutions that include forward and backward propagating fields and ASE were derived which were transcendental in nature but allowed for fairly easy computer calculations. Transverse ASE were calculated using the unsaturated gain resulting from longitudinal fields and were used to compare this with the longitudinal field equations. Large computer programs are now available at LANL which include the influence of transverse ASE on the longitudinal fields. However, none of these considerations have worried about the changes in the frequency characteristics of the propagating field or of how each of the frequency field components contributes to the saturation of the gain. The inclusion of full frequency characteristics to the analytic solutions of Hunter and Hunter proved impossible at least for this author and a new calculational technique was developed and is the subject of this talk. DOE

N91-22557# Lawrence Livermore National Lab., CA.
COLLISIONAL EXCITATION X RAY LASERS
D. Matthews, E. Chandler, L. DaSilva, D. Fields, W. H. Goldstein, C. Keane, J. Koch, R. London, B. MacGowan, and S. Maxon et al

14 Jan. 1991 18 p Presented at the 2nd International Colloquium on S ray Lasers, York, England, 17-21 Sep. 1990
(Contract W-7405-eng-48)
(DE91-010467; UCRL-JC-104404; CONF-9009266-13) Avail: NTIS HC/MF A03

The progress that has been made at numerous laboratories in the demonstration, optimization and understanding of so-called collisional excitation x ray lasers, i.e., lasers which involve amplification of the n = 3p to n =3 s transitions in Ne-like ions and the n = 4d (minus) 4p lines in Ni-like ions is reviewed. Currently, these schemes are producing x ray lasers which operate from approximately 32.6 nm to 3.6 nm and with output power into the few MW range. Efficiencies are low (less than or equal to 10(exp -6)) with the current means of pumping, i.e., with optical laser pumped plasma amplifiers. More efficient schemes may be forthcoming and will be discussed herein. Other important amplifier characteristics such as brightness, divergence and coherence are also being studied and the status of the knowledge of them will be discussed in this manuscript. Finally, the prospects for the development and application of compact, moderate cost collisional excitation lasers are discussed. DOE

N91-22558# California Univ., Berkeley. Lawrence Berkeley Lab.
REQUIREMENTS AND DESIGN OF A HIGH STABLE INFRARED FREE ELECTRON LASER AT LBL
K. J. Kim, M. Berz, S. Chattopadhyay, R. Gough, C. Kim, A. H. Kung, M. Xie, J. Edighoffer, and W. Stein Jun. 1990 4 p Presented at the 2nd European Particle Accelerator Conference ACROPOLIS, Nice, France, 11-16 Jun. 1990
(Contract DE-AC03-76SF-00098)
(DE91-009674; LBL-29232; CONF-900603-61; ESG-99) Avail: NTIS HC/MF A01

An infrared free electron laser (IRFEL) is being designed for the Chemical Dynamics Research Laboratory (CDRL) at LBL. The FEL is based on a 50 MeV RF linac operating in synchronization to the Advanced Light Source (ALS), and will produce intense (100 microjoules per micropulse), narrow bandwidth (narrower than 0.1 percent) radiation between 3 and 50 microns. In the design, we pay particular attention to the FEL stability issues and require that the fluctuations in electron beam energy and in timing be less than 0.05 percent and 0.1 ps, respectively. The FEL spectrum can then be stabilized to about 10(exp -3), or if grating is used, to 10(exp -4). We discuss various sources of fluctuations in the gun, the bunchers, and the accelerator sections, as well as the feedback and feedforward schemes to reduce these fluctuations. The accelerator structure is chosen to be of the side coupled, standing wave type for easier control. The beam transport is made isochronous to avoid the coupling between the energy and the timing fluctuations. DOE

N91-22559# Lawrence Livermore National Lab., CA.
A CALCULATION OF GAIN IN Ne-LIKE Ag SOFT X RAY LASERS
R. S. Walling, A. L. Osterheld, J. H. Scofield, W. H. Goldstein, M. D. Rosen, and M. H. Chen 1990 6 p Presented at the 2nd International Colloqium on X ray Lasers, York, England, 17-21 Sep. 1990
(Contract W-7405-eng-48)
(DE91-009758; UCRL-JC-104650; CONF-9009266-12) Avail: NTIS HC/MF A02

We describe results from ionization balance calculations and population inversion calculations for Ne-like Ag. We comment on the consistency of our results with recent observations of gain reported from the Nova Two-Beam Facility at Livermore. DOE

N91-22560# Los Alamos National Lab., NM.
POLYMERIC-HOST SULFORHODAMINE-B LASERS: DOUBLED Nd:YAG PUMPED
D. J. Gettemy, R. E. Hermes, and N. P. Barnes (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.) 1991 4 p Presented at the Advanced Solid-state Lasers Topical Meeting, Hilton Head, 18-20 Mar. 1991
(Contract W-7405-eng-36)
(DE91-009955; LA-UR-91-902; CONF-9103110-1) Avail: NTIS HC/MF A01

Solid-state dye lasers, pumped by a doubled Nd:YAG laser, were evaluated as a function of concentration, output coupler reflectivity and oscillator dimensions. A slope efficiency of up to 62 pct. was achieved. A maximum irradiance of 59 MW/sq cm to the dye laser cavity was achieved. DOE

N91-22157*# Lawrence Livermore National Lab., CA.
GROUND-TO-ORBIT LASER PROPULSION: ADVANCED APPLICATIONS
Jordin T. Kare *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 265-275
(For primary document see N91-22139 14-12)
(Contract W-7405-eng-48)
Avail: NTIS HC/MF A25 CSCL 20E

37 MECHANICAL ENGINEERING

Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

N91-22561*# North Carolina Univ., Charlotte. Dept. of Mechanical Engineering and Engineering Science.
MAGNETOSTRICTIVE DIRECT DRIVE MOTOR
Dipak Naik and P. H. DeHoff 20 Mar. 1991 22 p
(Grant NAG5-1169)
(NASA-CR-188006; TR-91-2; NAS 1.26:188006) Avail: NTIS HC/MF A03 CSCL 13I

Highly magnetostrictive materials such as Tb.3Dy.7Fe2, commercially known as TERFENOL-D, have been used to date in a variety of devices such as high power actuators and linear motors. The larger magnetostriction available in twinned single crystal TERFENOL-D, approx. 2000 ppm at moderate magnetic field strengths, makes possible a new generation of magnetomechanical devices. NASA researchers are studying the potential of this material as the basis for a direct microstepping rotary motor with torque densities on the order of industrial hydraulics and five times greater than that of the most efficient, high power electric motors. Such a motor would be a micro-radian stepper, capable of precision movements and self-braking in the power-off state. Innovative mechanical engineering techniques are juxtaposed on proper magnetic circuit design to reduce losses in structural flexures, inertias, thermal expansions, eddy currents, and magneto-mechanical coupling, thus optimizing motor performance and efficiency. Mathematical models are presented, including magnetic, structural, and both linear and nonlinear dynamic calculations and simulations. In addition, test results on prototypes are presented. Author

N91-22562*# Cincinnati Univ., OH. Dept. of Mechanical, Industrial, and Nuclear Engineering.
A NEW PROCEDURE FOR CALCULATING CONTACT STRESSES IN GEAR TEETH Final Report
Paisan Somprakit and Ronald L. Huston Apr. 1991 28 p
(Grant NsG-3188; DA Proj. 1L1-62211-A-47-A)
(NASA-CR-187094; NAS 1.26:187094; AVSCOM-TR-91-C-012)
Avail: NTIS HC/MF A03 CSCL 13I

A numerical procedure for evaluating and monitoring contact stresses in meshing gear teeth is discussed. The procedure is intended to extend the range of applicability and to improve the accuracy of gear contact stress analysis. The procedure is based upon fundamental solution from the theory of elasticity. It is an iterative numerical procedure. The method is believed to have distinct advantages over the classical Hertz method, the finite-element method, and over existing approaches with the boundary element method. Unlike many classical contact stress analyses, friction effects and sliding are included. Slipping and sticking in the contact region are studied. Several examples are discussed. The results are in agreement with classical results. Applications are presented for spur gears. Author

N91-22563# Aerospace Medical Research Labs., Wright-Patterson AFB, OH.
FORCE-REFLECTING INTERFACES TO TELEMANIPULATORS TESTING SYSTEM (FITTS) INTERIM USER'S GUIDE Interim Report, Jan. 1989 - Dec. 1990
Steven J. Remis and David K. Nelson Dec. 1990 28 p
(AD-A231484; AAMRL-SR-90-509) Avail: NTIS HC/MF A03 CSCL 23/2

This User's Guide specifies the procedures for operating the Force-reflecting Interfaces to Telemanipulators Testing System (FITTS) at the Harry G. Armstrong Aerospace Medical Research Laboratory. The report first describes each FITTS subsystem: the American Cimflex Merlin 6500 robots; the MB Associates exoskeleton; the AF/Navy Teleoperator Performance Evaluation Battery; and the control computers. After providing step by step procedures for initializing each subsystem, this User's Guide describes how to operate FITTS either by telemanipulation or by computer control. Next the report presents the process used to analyze experimental data collected with FITTS. Finally, a section is provided which describes error recovery steps to be used with FITTS. GRA

N91-22564# Dynamet Technology, Inc., Burlington, MA.
FEASIBILITY STUDY FOR THE QUALIFICATION OF AN ECONOMICALLY ADVANTAGEOUS Ti-6Al-4V BEARING HOUSING FOR GAS TURBINE ENGINE APPLICATION BY POWDER METAL MANUFACTURING TECHNOLOGY Final Report, Nov. 1988 - Apr. 1989
Stanley Abkowitz Jan. 1991 21 p
(Contract F33615-88-C-5504)
(AD-A231666; WRDC-TR-90-4140) Avail: NTIS HC/MF A03 CSCL 11/6

This Small Business Innovative Research (SBIR) Phase I program has demonstrated that titanium alloy aircraft engine components can be manufactured to near-net shape by an economical advanced powder metallurgy (P/M) process without compromising the structural performance and reliability of the component. In the program Ti-6A1-4V alloys test bar materials were made by the Dynamet CHIP process. Two types of alloy test material were evaluated, one utilizing standard low cost titanium powder containing 1500 ppm of chloride impurity and a second premium priced titanium powder with extra low levels of chloride. Tensile properties of the former material were near specified minimums for the forgings currently used in turbine engine components. For the extra low chloride material, however, tensile strength and ductility were far in excess of the specified minimums. GRA

N91-22565# Woods Hole Oceanographic Inst., MA.
COMPARATIVE DESIGN, MODELING, AND CONTROL ANALYSIS OF ROBOTIC TRANSMISSIONS Ph.D. Thesis
Hagen Schempf Aug. 1990 363 p
(Contracts N00014-86-C-0038; N00014-88-K-2022)
(AD-A231738; WHOI-90-43) Avail: NTIS HC/MF A16 CSCL 13/9

Transmission dynamics are shown to dominate the stability and performance of impedance-and torque controlled rotary electro-mechanical systems where sensor and actuator are noncolocated. The experimental part of the analysis focuses on planetary, cycloidal, harmonic and cable reducers. Simple transmission models are proposed to model such effects as (1) transmission stiffness, (2) soft-zones and wind-up, (3) backlash and lost motion, and (4) stiction, friction and viscous losses. These models are experimentally verified using six different transmission types most commonly used in robot designs. Simple lumped-parameter linear/nonlinear models are shown to predict stability margins and bandwidths fairly closely. Simple nonlinear lumped-and fixed-parameter models were unable to properly predict responses when the torque signals were of low-frequency and amplitude, underscoring the complexity in modeling the transmission-internal stick-slip phenomena. Transmission soft-zones are proven to reduce the stability margins of colocated impedance controlled and noncolocated torque-servoed electro-mechanical systems. None of the standard controller structures explored here could noticeably increase the system bandwidth of the closed loop system, without reducing the overall system performance. System damping, whether active or passive, as well as low pass filtering motor-controller signals, are shown to dramatically increase stability without having any effect on increasing system bandwidth. GRA

N91-22566*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COMPARISON OF ANALYSIS AND EXPERIMENT FOR DYNAMICS OF LOW-CONTACT-RATIO SPUR GEARS
Fred B. Oswald, Brian Rebbechi, James J. Zakrajsek, Dennis P. Townsend, and Hsiang Hsi Lin (Memphis State Univ., TN.) 1991 9 p Proposed for presentation at the 13th Biennial Conference on Mechanical Vibration and Noise, Miami, FL, 22-25 Sep. 1991; sponsored by ASME
(DA Proj. 1L1-61102-AH-45)
(NASA-TM-103232; E-5648; NAS 1.15:103232;
AVSCOM-TR-90-C-017) Avail: NTIS HC/MF A02 CSCL 13I

Low-contact-ratio spur gears were tested in NASA gear-noise-rig to study gear dynamics including dynamic load, tooth bending stress, vibration, and noise. The experimental results were compared with a NASA gear dynamics code to validate the code as a design tool for predicting transmission vibration and noise. Analytical predictions and experimental data for gear-tooth dynamic loads and tooth-root bending stress were compared at 28 operating conditions. Strain gage data were used to compute the normal load between meshing teeth and the bending stress at the tooth root for direct comparison with the analysis. The computed and measured waveforms for dynamic load and stress were compared for several test conditions. These are very similar in shape, which means the analysis successfully simulates the physical behavior of the test gears. The predicted peak value of the dynamic load agrees with the measurement results within an average error of 4.9 percent except at low-torque, high-speed conditions. Predictions of peak dynamic root stress are generally within 10 to 15 percent of the measured values. Author

N91-22567*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
HIGH TEMPERATURE PERFORMANCE EVALUATION OF A HYPERSONIC ENGINE CERAMIC WAFER SEAL
Bruce M. Steinetz Apr. 1991 23 p
(NASA-TM-103737; E-5942; NAS 1.15:103737) Avail: NTIS HC/MF A03 CSCL 13A

Leakage rates of an innovative hypersonic engine seal were measured using a specially developed static high temperature seal test fixture at NASA Lewis Research Center. The three foot long structural panel-edge seal is designed to minimize leakage of high temperature, high pressure gases past the movable panels of advanced ramjet/scramjet engines. The seal is made of a stack of precision machined ceramic wafer pieces that are inserted into a closely conforming seal channel in the movable engine panel. The wafer seal accommodates the significant distortions in the adjacent engine walls through relative sliding between adjacent wafers. Seal leakage rates are presented for engine simulated air temperatures up to 1350 F and for engine pressures up to 100 psi. Leakage rates are also presented for the seal, sealing both a flat wall condition, and an engine simulated distorted wall condition in which the distortion was 0.15 in. in only an 18 in. span. Seal leakage rates were low, meeting an industry-established tentative leakage limit for all combinations of temperature, pressure, and wall conditions considered. Comparisons are made between the measured leakage rates and leakage rates predicted using a seal leakage model developed from externally-pressurized gas film bearing theory. Author

N91-22568*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EVALUATION OF ADVANCED LUBRICANTS FOR AIRCRAFT APPLICATIONS USING GEAR SURFACE FATIGUE TESTS
Dennis P. Townsend and John Shimski (Naval Air Propulsion Test

Center, Trenton, NJ.) 1991 13 p Proposed for presentation at the 27th Joint Propulsion Conference, Sacramento, CA, 24-26 Jun. 1991; cosponsored by AIAA, SAE, ASEE, and ASME
(DA Proj. 1L1-66211-A-47-A)
(NASA-TM-104336; E-6044; NAS 1.15:104336;
AVSCOM-TR-91-C-007; AIAA-91-1907) Avail: NTIS HC/MF A03 CSCL 11H

Surface pitting fatigue life tests were conducted with five lubricants, using spur gears made from a single lot of consumable-electrode vacuum melted (CVM) AISI 9310 steel. The gears were case carbonized and hardened to a Rockwell c-60 and finish ground. The gear pitch diameter was 8.89 cm. The lot of gears was divided into five groups, each of which was tested with a different lubricant. The test lubricants can be classified as synthetic polyol-esters with various viscosities and additive packages. Test conditions included bulk gear temperature of 350 K, a maximum Hertz stress of 1.71 GPa (248 ksi) at the pitch line, and a speed of 10,000 RPM. The lubricant with a viscosity that provided a specific film thickness greater than one and with an additive package produced far greater gear surface fatigue lives than lubricants with a viscosity that provided specific film thickness less than one. A low viscosity lubricant with an additive package produced gear surface fatigue lives equivalent to a similar base stock lubricant with 30 percent higher viscosity, but without an additive package. Lubricants with the same viscosity and similar additive packages gave equivalent gear surface fatigue lives.
Author

N91-22569*# Maryland Univ., College Park. Dept. of Electrical Engineering.
REAL TIME CONTROL FOR NASA ROBOTIC GRIPPER Final Report
Carole A. Salter and John S. Baras Mar. 1990 20 p
(Grant NAG5-1047)
(NASA-CR-187957; NAS 1.26:187957) Avail: NTIS HC/MF A03 CSCL 13I

The ability to easily manipulate objects in a zero gravity environment will pay a key role in future space activities. Emphasis will be placed on robotic manipulation. This will serve to increase astronaut safety and utility in addition to several other benefits. The aim is to develop control laws for the zero gravity robotic end effectors. A hybrid force/position controller will be used. Sensory data available to the controller are obtained from an array of strain gauges and a linear potentiometer. Applying well known optimal control theoretical principles, the control which minimizes the transition time between positions is obtained. A robust force control scheme is developed which allows the desired holding force to be achieved smoothly without oscillation. In addition, an algorithm is found to determine contact force and contact location.
Author

N91-22570*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CONTACT STRESSES IN GEAR TEETH: A NEW METHOD OF ANALYSIS
Paisan Somprakit, Ronald L. Huston (Cincinnati Univ., OH.), and Fred B. Oswald 1991 16 p Proposed for presentation at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; cosponsored by AIAA, SAE, ASME, and ASEE
(Grant NsG-3188; DA Proj. 1L1-62211-A-47-A)
(NASA-TM-104397; E-6214; NAS 1.15:104397;
AVSCOM-TR-91-C-001; AIAA-91-2022) Avail: NTIS HC/MF A03 CSCL 13I

A new, innovative procedure called point load superposition for determining the contact stresses in mating gear teeth. It is believed that this procedure will greatly extend both the range of applicability and the accuracy of gear contact stress analysis. Point load superposition is based upon fundamental solutions from the theory of elasticity. It is an iterative numerical procedure which has distinct advantages over the classical Hertz method, the finite element method, and over existing applications with the boundary element method. Specifically, friction and sliding effects, which are either excluded from or difficult to study with the classical methods, are routinely handled with the new procedure. Presented here are the basic theory and the algorithms. Several examples are given. Results are consistent with those of the classical theories. Applications to spur gears are discussed.
Author

N91-22571*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DEVELOPMENT OF BRAIDED ROPE SEALS FOR HYPERSONIC ENGINE APPLICATIONS. PART 2: FLOW MODELING
Rajakkannu Mutharasan, Bruce M. Steinetz, Xiaoming Tao, and Frank Ko (Drexel Univ., Philadelphia, PA.) 1991 13 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-26 Jun. 1991; sponsored by AIAA, SAE and ASME
(NASA-TM-104371; E-6166-Pt-2; NAS 1.15:104371;
AIAA-91-2495-PT-2) Avail: NTIS HC/MF A03 CSCL 11A

Two models based on the Kozeny-Carmen equation were developed to analyze the fluid flow through a new class of braided rope seals under development for advanced hypersonic engines. A hybrid seal geometry consisting of a braided sleeve and a substantial amount of longitudinal fibers with high packing density was selected for development based on its low leakage rates. The models developed allow prediction of the gas leakage rate as a function of fiber diameter, fiber packing density, gas properties, and pressure drop across the seal.
Author

N91-22167*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MINI-ROVERS FOR MARS EXPLORATIONS
David P. Miller *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 365-370 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 13F

N91-23045*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
ROBOTICS IN SPACE-AGE MANUFACTURING
Chip Jones *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 199-207 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13I

N91-23046*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
VARIABLE POLARITY ARC WELDING
E. O. Bayless, Jr. *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 208-213 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13H

N91-23047*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
HIGH PRESSURE WATER JET CUTTING AND STRIPPING
David T. Hoppe and Majid K. Babai *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 214-220 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13H

N91-23059*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
ROBOSIM, A SIMULATOR FOR ROBOTIC SYSTEMS
Elaine M. Hinman, Ken Fernandez, and George E. Cook (Vanderbilt Univ., Nashville, TN.) *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 309-314 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13I

N91-23061*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
TELEROBOTIC ELECTRONIC MATERIALS PROCESSING EXPERIMENT
Stanford Ollendorf *In* National Aeronautics and Space

Administration, Technology 2000, Volume 1 Mar. 1991 p 322-327 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13H

N91-23062*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
ADVANCED MECHANISMS FOR ROBOTICS
John M. Vranish *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 328-335 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13I

N91-23063*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE FLIGHT TELEROBOTIC SERVICER AND TECHNOLOGY TRANSFER
James F. Andary and Kayland Z. Bradford (Martin Marietta Corp., Denver, CO.) *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 336-343 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13I

N91-23064*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
FARMS: THE FLEXIBLE AGRICULTURAL ROBOTICS MANIPULATOR
Paul S. Gill *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 344-349 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13I

38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

N91-22572 Iowa State Univ. of Science and Technology, Ames.
MODEL-BASED ULTRASONIC FLAW CLASSIFICATION AND SIZING Ph.D. Thesis
Chien-Ping Chiou 1990 166 p
Avail: Univ. Microfilms Order No. DA9101339

In the ultrasonic testing of materials for flaws, it is important to be able both to identify the flaw type (flaw classification) as well as to predict the flaw shape, orientation, and size parameters (flaw sizing). Techniques for both classification and sizing are described. In particular, a flaw classification technique is considered that employs mode-converted diffracted signals in a quasi-pulse-echo configuration to distinguish smooth vs. sharp-edge flaws. For the flaw sizing applications, three approaches are presented. These approaches include the following: (1) a non-iterative equivalent sizing method where the best equivalent ellipsoid (for volumetric flaws) or ellipse (for cracks) is found that matches the scattering data; (2) a spherical harmonics expansion algorithm; and (3) the use of neural networks for equivalent flaw sizing. In addition, the effect of classification information on the sizing problem is considered. A technique for correcting systematic errors in sizing cracks due to the finite bandwidth of ultrasonic transducers is described, and an enhanced adaptive learning method that can speed up the training of a neural network is presented. Author

N91-22573*# Thiokol Corp., Brigham City, UT. Space Operations.
EARLY FOCUS DEVELOPMENT EFFORT, ULTRASONIC INSPECTION OF FIXED HOUSING METAL-TO-ADHESIVE BONDLINE Final Report
John K. Hartmann, Brad R. Hoskins, and Paul Karner Mar. 1991 29 p
(Contract NAS8-30490)
(NASA-CR-184143; NAS 1.26:184143; TWR-61684; Publ-911382)
Avail: NTIS HC/MF A03 CSCL 14D

An ultrasonic technique was developed for the fixed housing metal-to-adhesive bondline that will support the Flight 15 time frame and subsequent motors. The technique has the capability to detect a 1.0 inch diameter unbond with a 90 percent probability of detection (POD) at a 95 percent confidence level. The technique and support equipment will perform within the working envelope dictated by a stacked motor configuration. Author

N91-22574# Modern Analysis, Inc., Ridgewood, NJ.
RELATION OF INSPECTION FINDINGS TO FATIGUE RELIABILITY Final Report
M. Shinozuka 3 Dec. 1990 116 p
(Contract DTCG23-86-C-20057)
(AD-A231819; SR-1317; SSC-355) Avail: NTIS HC/MF A06 CSCL 13/10

The main objective of this work was to develop an aperiodic inspection procedure for marine structures so as to maintain their reliability at a predetermined design level throughout the design life. A summary of current inspection procedures for a variety of marine structures is provided. Limited information makes it very difficult to assess the reliability of inspection techniques. Probability of detection (POD) curve used in the aerospace industry for flaw detection were reviewed and provided a guide for establishing POD curves for the marine industry. Aperiodic inspection procedures based on Bayesian upgrading and POD cures, component stress levels, and structural inspection and repair histories are developed. Validity and effectiveness of the Bayesian analysis is demonstrated by numerical example. Current inspection procedures are generally incompatible with the probabilistic approach this work intends to develop. GRA

N91-22575# Technische Univ., Eindhoven (Netherlands).
THE ANALYSIS OF FAULT DIAGNOSIS TASKS: DO VERBAL REPORTS SPEAK FOR THEMSELVES Ph.D. Thesis
Jan Albert Brinkman 1990 258 p
(ETN-91-99180) Avail: NTIS HC/MF A12

The applicability of verbal protocol methodology in the task domain of fault diagnosis, and more specifically whether verbal reports possess the potential to yield an accurate account of the cognitive processes involved in fault diagnosis, are investigated. Two forms of inaccurate verbal reporting, reactivity and lack of validity, are described. Theoretical works by Nisbett and Wilson and Ericsson and Simon, which appear to be in confliction, are discussed. The approach according to which empirical tests of verbal report accuracy are generally carried out is outlined. The Ericsson and Simon model is applied to identify factors determining accuracy. The nature of diagnostic activities to be reported and the form in which reports are delivered seem to be crucial factors. The first factor distiguishes between 'topographical' and 'functional search'. Experiments are carried out using one task which is supposed to require a topographic search and another the functional search, both computer implemented and requiring the subjects to interact with keyboard display system. Results are combined and interpreted in the light of predictions drawn from the Ericsson and Simon model. ESA

N91-22268# Vincotte, Brussels (Belgium). Nuclear Safety Analysis Dept.
POSSIBLE USE OF RELIABILITY AND SAFETY ANALYSES FROM OTHER TECHNOLOGIES
Pierre Govaerts *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 495-500 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-23050*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
RELIABILITY AND RISK ASSESSMENT OF STRUCTURES
C. C. Chamis *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 241-248 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 14D

39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance.*

N91-22576*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPUTATIONAL METHODS FOR FRICTIONLESS CONTACT WITH APPLICATION TO SPACE SHUTTLE ORBITER NOSE-GEAR TIRES
Kyun O. Kim, John A. Tanner, Ahmed K. Noor (Virginia Univ., Charlottesville.), and Martha P. Robinson Washington May 1991 36 p Original contains color illustrations
(NASA-TP-3073; L-16750; NAS 1.60:3073) Avail: NTIS HC/MF A03; 2 functional color pages CSCL 20K

A computational procedure is presented for the solution of frictionless contact problems of aircraft tires. The Space Shuttle nose-gear tire is modeled using 2-D laminated anisotropic shell theory with the effects of variation in material and geometric parameters, transverse shear deformation, and geometric nonlinearities included. The contact conditions are incorporated into the formulation by using a perturbed Lagrangian approach with the fundamental unknowns consisting of the stress resultants, the generalized displacements, and the Lagrange multipliers associated with the contact conditions. The elemental arrays are obtained by using a modified two-field, mixed variational principle. Numerical results are presented for the Space Shuttle nose-gear tire when subjected to inflation pressure and pressed against a flat plate. Comparison is made with experiments conducted at NASA-Langley. The detailed information presented assists in gaining physical insight about the structural response of the tire. The numerical studies have demonstrated the high accuracy of the mixed formulation models and the effectiveness of the computational procedure which combines both the geometrically nonlinear terms and the contact conditions in one iteration loop.
Author

N91-22577*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Engineering Science and Mechanics.
THE INFLUENCE OF TIME-DEPENDENT MATERIAL BEHAVIOR ON THE RESPONSE OF SANDWICH BEAMS Interim Report No. 83, Sep. 1988 - Dec. 1990
Lynda Lee Sensmeier-Oleksuk, Michael W. Hyer, and David E. Bowles (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.) Feb. 1991 185 p
(Grant NAG1-343)
(NASA-CR-188029; NAS 1.26:188029; CCMS-91-05; VPI-E-91-02) Avail: NTIS HC/MF A09 CSCL 20K

Simple sandwich beam models are developed in order to study the influence of the time-dependent behavior of various materials being considered for use in orbiting precision segmented reflectors. The beam models included layers representing face sheets, core, and adhesive. The issue of time-dependency is essential because the expected life of a reflector is on the order of 20 years. Using the principle of stationary potential energy, the elastic response of three-layer and five-layer sandwich beams to mechanical and thermally-induced loads is studied. The sensitivity of the three-layer and five-layer sandwich beams to reductions of the material properties are used to demonstrate the application of the correspondence principle and evaluate the time-dependent response of the reflector. To verify the viscoelastic models and obtain a better idea of the amount of time-dependency to expect from the materials, simple time-dependent experiments on candidate materials were performed. Candidate materials include a quartz-epoxy face sheet material, and a glass-imide honeycomb core material. The percent increase in strain for a constant stress for the quartz-epoxy in tension and the honeycomb in shear were measured. For both, a four-parameter fluid model captured the essential characteristics of their behavior. These four-parameter fluid models were then used in the three-layer sandwich beam model to predict the time-dependent response of the beam to three-point bending. This prediction response was compared to experimental results of a sandwich beam subjected to three-point bending.
Author

N91-22578*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SENSITIVITY-BASED SCALING FOR CORRELATING STRUCTURAL RESPONSE FROM DIFFERENT ANALYTICAL MODELS
Kwan J. Chang, Raphael T. Haftka, Gary L. Giles, and Pi-Jen Kao (Analytical Services and Materials, Inc., Hampton, VA.) Feb. 1991 11 p
(Grant NAG1-224)
(NASA-TM-104042; NAS 1.15:104042) Avail: NTIS HC/MF A03 CSCL 20K

A sensitivity-based linearly varying scale factor is described used to reconcile results from refined models for analysis of the same structure. The improved accuracy of the linear scale factor compared to a constant scale factor as well as the commonly used tangent approximation is demonstrated. A wing box structure is used as an example, with displacements, stresses, and frequencies correlated. The linear scale factor could permit the use of a simplified model in an optimization procedure during preliminary design to approximate the response given by a refined model over a considerable range of design changes.
Author

N91-22579 Columbia Univ., New York, NY.
FINITE ELEMENT ANALYSIS IN NONISOTHERMAL VISCOPLASTICITY Ph.D. Thesis
Marc S. Benowitz 1990 103 p
Avail: Univ. Microfilms Order No. DA9102402

A method of analyzing the fully coupled thermomechanical transient behavior of solids is proposed for elastic/viscoplastic materials subject to finite strains. Using the material description, the governing equations are developed in accordance with the principles of thermodynamics and continuum mechanics. The presence of finite strains is included by using the exact strain-displacement relation and the exact measure of volumetric deformation. The von Mises yield condition is assumed valid in terms of the Cauchy stresses, in the spatial frame of reference. The yield condition, when transformed back into the material frame of reference, in terms of the Piola-Kirchoff stresses, now includes additional terms that account for the deformation. The constitutive relation for the Piola-Kirchoff stresses and the coupled heat conduction equation are developed from an assumed form of the free energy. This free energy expression is capable of modeling finite strains without the use of additional thermoelastic material constants, other than the two elastic moduli and the coefficient of thermal expansion. The correct terms for thermoelastic and thermoinelastic coupling are included in the free energy expression. In the case of the thermoelastic coupling term, the exact measure of volumetric strains is used. For the thermoinelastic coupling term, a portion of the rate of inelastic work is dissipated as heat. The resulting constitutive relation for stress is nonlinear in strain, due to the volumetric strain term, and dependent on temperature, due to thermal stresses and temperature-dependent material properties. The heat conduction equation contains coupling terms between the mechanical and thermal variables. The resulting governing equations for the transient mechanical and thermal processes are nonlinear and coupled. A numerical procedure for solution of the coupled system of equations is developed using finite elements and explicit time integration. Application of the proposed method to problems of simple shear and tension is presented.
Dissert. Abstr.

N91-22580 Texas Univ., Austin.
INTERFACIAL CRACK INITIATION UNDER BIAXIAL LOADING Ph.D. Thesis
Young Suck Chai 1990 150 p
Avail: Univ. Microfilms Order No. DA9031534

Mixed mode crack initiation along bimaterial interfaces was studied. A experimental and numerical approach was use that

studied inelastic effects. A single specimen in conjunction with a biaxial loading device was used for obtaining a wide range of fracture mode mixes. The specimen geometry selected was an edge cracked bimaterial strip, which gave rise to crack length independence of fracture parameters and mode mix. A biaxial loading device, which was capable of controlling applied displacements in two perpendicular directions was developed and used for crack initiation experiments. In addition to the usual measurements of load and displacement, normal crack opening displacements were measured near the crack front using crack opening interferometry in order to examine near-tip asymptotics, crack face contact, and 3-D effects. From the mixed mode crack initiation experiments, it could be seen that there was a large increase in toughness with larger mode II components. The singularities at the intersection of an interfacial crack front and a traction free surface were examined. The strain singularities at the edges were stronger than those near the center.
Dissert. Abstr.

N91-22581 Iowa State Univ. of Science and Technology, Ames.
THE BOUNDARY ELEMENT METHOD APPLIED TO STATIC AND DYNAMIC CRACK PROBLEMS USING HYPERSINGULAR BOUNDARY INTEGRAL EQUATIONS Ph.D. Thesis
Gunaseelan Krishnasamy 1990 127 p
Avail: Univ. Microfilms Order No. DA9101360

The need for hypersingular boundary integral equations in crack problems is motivated through acoustic and elastic wave scattering from a thin screen and crack. By integrating over a small neighborhood about the singular point and the rest of the boundary, and by identifying terms from the integrals over the two surfaces which cancel each other, the finite-part of the hypersingular integral is defined for curved surfaces in both two and three dimensions. Stokes' theorem is used to regularize the hypersingular integrals to a form conducive to simple numerical integration techniques. With no prior assumptions on the discretization or integration by parts, this method results in integrals which are at most weakly singular. The equivalence of this approach to the finite-part of the hypersingular integral is established. The necessary condition on the density function for the hypersingular integral equation to have meaning and the consequences on the solution of not satisfying the necessary conditions are discussed. This new formulation places restrictions on the choice of shape functions and the possible location of the collocation points within elements due to the smoothness requirement on the density function. Such restrictions for regular boundary integral equations with Cauchy principle value integrals are also discussed. The different kinds of integrals encountered in a hypersingular boundary integral equation such as weakly singular, nearly singular, regular area, and line integrals are studied. Discretization considerations for precise and efficient numerical computation of these integrals in the context of the boundary element method are established, and the influence of discretization on the solution is highlighted through numerical examples. Examples are chosen from problems of acoustic and elastic wave scattering from thin screens and cracks in three dimensions. Dissert. Abstr.

N91-22582 Southampton Univ. (England).
THE MEASUREMENT OF STRUCTURAL WAVE INTENSITY Ph.D. Thesis
William Redmond-White 1983 222 p
Avail: Univ. Microfilms Order No. BRDX90381

In attempting to control vibration in structures it is desirable to be able to identify dominant paths of vibration transmission from sources (e.g., machines) through the structure to some point of interest. It is therefore necessary to be able to measure the vibration power flow at a point in a structure, possibly in the presence of large stationary wave amplitudes. By repeating measurements at many positions on a structure it should be possible to build up a pattern representing paths of significant power transmission. Several measurement methods were investigated, both analytically and experimentally, to identify those most suitable for practical use. It was shown that measurement dynamic range is the major limitation, and that this characteristic is governed by the instrumentation phase tolerances. Simplified methods were shown to provide the best dynamic range coupled with acceptable accuracy in use. An electronic intensity meter, capable of narrow bandwidth measurements in real time, was designed and constructed and results obtained on beam and plate type structures. Dissert. Abstr.

N91-22583 Brown Univ., Providence, RI.
MICROMECHANISMS OF QUASI-STATIC AND FATIGUE CRACK GROWTH IN TITANIUM-ALUMINIDES Ph.D. Thesis
Pranesh Belgod Aswath 1990 217 p
Avail: Univ. Microfilms Order No. DA9101728

The rapid development of advanced aerospace technology has put an increasing demand on the development of a new generation of structural materials for aircraft engines. Intermetallic materials with low densities and improved fracture toughness at elevated temperature show promise for replacing widely used Ni-base superalloys. TiAl and Ti3Al, ordered intermetallic compounds of Ti and Al, have been the subject of increasing research activity in the recent past because of their light weight and high strength. An understanding of the resistance to quasi-static and cyclic load fracture in these intermetallics at both ambient and elevated temperatures is of paramount importance for damage-tolerant, fatigue-critical structural applications for which the intermetallics are candidate materials. The effects of microstructure, microstructural stability, mechanical variables (such as load ratio and fatigue frequency), and temperature on the the quasi-static and fatigue crack growth characteristics of Ti-Al and Ti-Al-Nb alloys. With the aid of controlled heat treatments, duplex microstructures comprising either alpha(sub 2) and beta or alpha(sub 2) and gamma phases as well as predominantly alpha(sub 2) phase microstructures are produced. The fatigue crack growth characteristics are monitered over a range of delta K values from threshold to final failure. The effects of controlled microstructures on the overall fatigue and fracture resistance are examined in light of transmission electron microscopy (TEM) observations of crack tip damage, scanning auger spectroscopy of fracture surface oxidation, and scanning electron fractography. The stability of these microstructures are examined in light of their response to both fatigue crack growth and fracture toughness. Microstructural features which lead to a betterment of fatigue crack growth and fracture toughness are discussed in context of the present experimental results. Author

N91-22584 Stanford Univ., CA.
THE DEVELOPMENT AND ANALYSIS OF NEW TECHNIQUES FOR MEASURING THE STRENGTH AND STIFFNESS OF THIN FILMS AND THE SLIDING RESISTANCE OF STIFF FIBERS IN A CERAMIC MATRIX Ph.D. Thesis
Timothy Patrick Weihs 1990 177 p
Avail: Univ. Microfilms Order No. DA9102370

Parallel efforts to develop and utilize micromechanical techniques for measuring mechanical properties of thin films and ceramic fiber composites are reported. The work has been mainly experimental and has centered around the use of a load controlled submicron indentation instrument called the Nanoindenter. Because of its ability to apply small loads (0.25 microN0 and to measure small displacements (0.3 nm), the instrument is ideally suited for the micromechanical measurements that were developed. The first micromechanical technique was developed to measure a stiff fiber's resistance to sliding within a ceramic matrix. Using the Nanoindenter, fibers aligned normal to a polished composite surface were forced to slide along their complete length until they protruded from the bottom of a thin sampled. By simply inverting the sample and loading the protruding fibers, the frictional resistance to reverse sliding was measured directly as well. In the case of significant friction at the fiber/matrix interface, the sliding resistance was measured indirectly by monitoring the deflection of a fiber down into the matrix, since the fiber could not slide along its complete length. Using these two techniques and a model ceramic matrix composite of Nicalon(SiC) fibers and a glass matrix, changes in the sliding resistance of fibers were correlated with changes in the mechanical properties of the bulk composite. The

second micromechanical technique was developed to measure the strength and stiffness of films with thicknesses in the micron to submicron range. It utilizes conventional IC processing to fabricate single and bilayer cantilever microbeams of typical interconnect metals, passivating materials, and semiconducting materials. Single-layer and bilayer beams of Au, Si, SiO2, and SiN(x) were mechanically deflected using the Nanoindenter. The resulting load-deflection data was then analyzed using simple beam theory to measure the Young's moduli, yield strengths, and residual stresses of these materials. Dissert. Abstr.

N91-22585 Idaho Univ., Moscow.
MODAL ANALYSIS OF A FLUID-FILLED ELASTIC SHELL CONTAINING AN ELASTIC SPHERE Ph.D. Thesis
Joseph C. Guarino 1990 104 p
Avail: Univ. Microfilms Order No. DA9102191

Auscultatory percussion (AP) is an examination used to detect brain disease. The physical mechanisms involved in AP are investigated by determining the natural frequencies and mode shapes of a fundamental physical system. The fundamental physical system is an elastic, fluid-filled spherical shell containing a concentrically-located elastic sphere. The major assumptions in the analysis are that the fluid is inviscid, the spherical shell is thin, and the modes of the physical system are axisymmetric. An analytical modal analysis results in a characteristic equation for the natural frequencies of the physical system. Roots of the characteristic equation are obtained numerically for the near-audible frequency range. Natural frequencies and mode shapes are presented for twenty cases. The results show that the spectra of natural frequencies for the physical system are distorted by the combined effects of volume exclusion and the elasticity of the inner sphere. The elastic inner sphere also introduces a pattern of additional frequencies to the spectra of natural frequencies of the physical system. Dissert. Abstr.

N91-22586 Brown Univ., Providence, RI.
PROBLEMS ASSOCIATED WITH DYNAMIC FRACTURE UNDER HIGH STRAIN RATE LOADING Ph.D. Thesis
Yeong Joo Lee 1990 154 p
Avail: Microfilms Order No. DA9101796

The mechanics of dynamic fracture in strain rate dependent materials, typically structural metals, is investigated. Observations on high strain rate crack growth based on a strip yield model are considered. Rate dependence of plastic flow is taken into account by assuming that the cohesive stress in the yield zone depends linearly on the local rate of opening in the yield zone. The conditions under which a crack can advance steadily according to either of two criteria are considered. Fracture initiation due to asymmetric impact loading of an edge cracked plate is studied. The two dimensional elastodynamic problem of a semi-infinite plate containing an edge crack is considered. Fracture initiation in an elastic viscoplastic material is also considered. Dissert. Abstr.

N91-22587*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ENVIRONMENTAL FATIGUE OF AN Al-Li-Cu ALLOY. PART 1: INTRINSIC CRACK PROPAGATION KINETICS IN HYDROGENOUS ENVIRONMENTS
Robert S. Piascik and Richard P. Gangloff (Virginia Univ., Charlottesville.) Mar. 1991 48 p
(NASA-TM-104064; NAS 1.15:104064) Avail: NTIS HC/MF A03 CSCL 20K

Deleterious environmental effects on steady-state, intrinsic fatigue crack propagation (FCP) rates (da/dN) in peak aged Al-Li-Cu alloy 2090 are established by electrical potential monitoring of short cracks with programmed constant delta K and K(sub max) loading. The da/dN are equally unaffected by vacuum, purified helium, and oxygen but are accelerated in order of decreasing effectiveness by aqueous 1 percent NaCl with anodic polarization, pure water vapor, moist air, and NaCl with cathodic polarization. While da/dN depends on delta K(sup 4.0) for the inert gases, water vapor and chloride induced multiple power-laws, and a transition growth rate 'plateau'. Environmental effects are strongest at low delta K. Crack tip damage is ascribed to hydrogen embrittlement because of the following: (1) accelerated da/dN due to part-per-million levels of H2O without condensation; (2) impeded molecular flow model predictions of the measured water vapor pressure dependence of da/dN as affected by mean crack opening; (3) the lack of an effect of film-forming O2; (4) the likelihood for crack tip hydrogen production in NaCl, and (5) the environmental and delta K-process zone volume dependencies of the microscopic cracking modes. For NaCl, growth rates decrease with decreasing loading frequency, with the addition of passivating Li2CO3, and upon cathodic polarization. These variables increase crack surface film stability to reduce hydrogen entry efficiency. The hydrogen environmental FCP resistance of 2090 is similar to other 2000 series alloys and is better than 7075. Author

N91-22588*# Texas A&M Univ., College Station. Dept. of Civil Engineering.
FAILURE PREDICTION OF THIN BERYLLIUM SHEETS USED IN SPACECRAFT STRUCTURES Semiannual Status Report, 1 Jul. - 31 Dec. 1990
Paul N. Roschke, Photios Papados, and Edward Mascorro 1991 34 p
(Grant NAG9-280)
(NASA-CR-188167; NAS 1.26:188167) Avail: NTIS HC/MF A03 CSCL 20K

In an attempt to predict failure for cross-rolled beryllium sheet structures, high order macroscopic failure criteria are used. These require the knowledge of in-plane uniaxial and shear strengths. Test results are included for in-plane biaxial tension, uniaxial compression for two different material orientations, and shear. All beryllium specimens have the same chemical composition. In addition, all experimental work was performed in a controlled laboratory environment. Numerical simulation complements these tests. A brief bibliography supplements references listed in a previous report. Author

N91-22589*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STRUCTURAL INTEGRITY OF WIND TUNNEL WOODEN FAN BLADES
Clarence P. Young, Jr., Robert T. Wingate, James R. Rooker, Kenneth W. Mort (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.), and Harold E. Zager Apr. 1991 75 p
(NASA-TM-104059; NAS 1.15:104059) Avail: NTIS HC/MF A04 CSCL 20K

Information is presented which was compiled by the NASA Inter-Center Committee on Structural Integrity of Wooden Fan Blades and is intended for use as a guide in design, fabrication, evaluation, and assurance of fan systems using wooden blades. A risk assessment approach for existing NASA wind tunnels with wooden fan blades is provided. Also, state of the art information is provided for wooden fan blade design, drive system considerations, inspection and monitoring methods, and fan blade repair. Proposed research and development activities are discussed, and recommendations are provided which are aimed at future wooden fan blade design activities and safely maintaining existing NASA wind tunnel fan blades. Information is presented that will be of value to wooden fan blade designers, fabricators, inspectors, and wind tunnel operations personnel. Author

N91-22590# Advanced Research and Applications Corp., Sunnyvale, CA.
A NEW NDE CAPABILITY FOR THIN-SHELLED STRUCTURES Final Technical Report, Sep. 1985 - Apr. 1988
Robert N. Yancey and James H. Stanley 3 Feb. 1989 33 p
(Contract F33615-85-C-5145)
(AD-A231578; ARACOR-FR468-88; AFWAL-TR-88-4225) Avail: NTIS HC/MF A03 CSCL 20/11

A need currently exists for a fast, effective x ray imaging method for inspection of advanced solid rocket motor components. A technique known as laminography was proposed as an accurate method to obtain x ray images of thin slices of thin walled structures

in a fraction of the time required for computed tomography (CT) inspection. A program was undertaken to construct a preprototype laminography scan system. The design of the scan system, the procurement of subsystem hardware, the assembly and checkout of subsystem components, and the integration of the subsystems into a complete preprototype laminography system also capable of accommodating a dual energy capability were all completed as part of this program. The result of the program is a fully operational preprototype Laminography/Dual Energy system. Author

N91-22591# Texas A&M Univ., College Station.
ELASTIC - PLASTIC FRACTURE MECHANICS. PART 1: A CRITICAL REVIEW Final Report
T. L. Anderson Apr. 1990 155 p
(Contract DTCG23-88-C-20071)
(AD-A231909; SR-1321-Pt-1; SSC-345-Pt-1) Avail: NTIS HC/MF A08 CSCL 13/5

The history and current state-of-the-art in elastic-plastic fracture mechanics as applied to welded steel structures is reviewed. Fundamental concepts and underlying assumptions are described. Standardized test methods and recent developments are reviewed. The results of a parametric study comparing several elastic-plastic design analyses are presented. GRA

N91-22592# Army Lab. Command, Watertown, MA. Material Technology Lab.
A COMPUTATIONALLY ATTRACTIVE BEAM THEORY ACCOUNTING FOR TRANSVERSE SHEAR AND NORMAL DEFORMATIONS Final Report
Alexander Tessler Jan. 1991 26 p
(AD-A231938; MTL-TR-91-4) Avail: NTIS HC/MF A03 CSCL 20/11

In the simplest cases of beam bending, vibration and stability, analytic solutions can be obtained using the Bernoulli-Euler (classical) or Timoshenko beam theories, with the latter accounting for the deformation due to transverse shear. Analytic solutions can be either difficult or impossible to obtain for the many practical applications of beams as reinforcing members in plate and shell structures and whenever nonlinear deformation/material behavior is considered. In all of these cases, the finite element method enables the analyst to obtain sufficiently accurate approximate solutions. The principal benefit of the Timoshenko beam modeling is the ability to properly account for transverse shear deformation, the effect that can be significant in deep beams and those made of laminated composites which are known to exhibit relatively low transverse shear stiffness. Since the Timoshenko theory does not account for the deformation in the transverse normal direction, it precludes solutions to problems which lend themselves to the 3-D state of stress. An example is the composite beam subject to impact loading or high frequency vibrational modes (i.e., short wavelength loading). GRA

N91-22593# Wright Research Development Center, Wright-Patterson AFB, OH.
TENSILE MODULUS BY X RAY DIFFRACTION: INSTRUMENT AND METHOD Final Report, Jul. 1986 - Jun. 1990
P. G. Lenhert and W. W. Adams Jul. 1990 79 p
(AD-A231991; WRDC-TR-90-4070) Avail: NTIS HC/MF A05 CSCL 07/6

The design and use of an automated device to measure the axial tensile modulus of high modulus fibers by following the change in the meridional x ray spacings as a function of applied tension is reported. The device, which mounts on a Picker 4-circle automated diffractometer, applies tension to the fiber sample by a cantilever arrangement. Tension, which is measured by a strain gauge bridge on the cantilever arm, is adjusted and read by the control computer, a VAX 11/730. The device can also be used to study sample orientation as a function of tension. Techniques applicable to modulus measurements on a variety of man-made and natural fibers are discussed. The examples include rigid-rod polymer materials, poly(paraphenylene benzobisthiazole (PBZT), and poly(paraphenylene benzobisoxazole) (PBO), carbon fibers with various degrees of order, KEVLARTM 149, and degummed silk. GRA

N91-22594*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ANALYSIS OF SOME COMPLIANCE CALIBRATION DATA FOR CHEVRON-NOTCH BAR AND ROD SPECIMENS
Thomas W. Orange, Raymond T. Bubsey, William S. Pierce, and John L. Shannon, Jr. 1991 14 p Presented at the Symposium on Chevron-Notch Fracture Test Experience, Indianapolis, IN, 6 May 1991; sponsored by the American Society for Testing and Materials
(NASA-TM-104367; E-6167; NAS 1.15:104367) Avail: NTIS HC/MF A03 CSCL 20K

A set of equations describing certain fracture mechanics parameters for chevron-notch bar and rod specimens are presented. They are developed by fitting earlier compliance calibration data. The difficulty in determining the minimum stress intensity coefficient and the critical crack length is discussed. Author

N91-22595*# Lockheed Missiles and Space Co., Palo Alto, CA.
THE COMPUTATIONAL STRUCTURAL MECHANICS TESTBED STRUCTURAL-ELEMENT PROCESSOR ES1: BASIC SRI AND ANS SHELL ELEMENTS
Gary M. Stanley Washington NASA May 1991 66 p
(Contract NAS1-18444)
(NASA-CR-4357; NAS 1.26:4357; LMSC-D878511) Avail: NTIS HC/MF A04 CSCL 20K

The theory is documented behind the CSM Testbed structural finite element processor ES1 for basic SRI and ANS shell elements. Processor ES1 contains various displacement-based selective-reduced integrated (SRI) and assumed natural coordinate strain (ANS) transverse shear deformable shell elements, including 4 and 9 node quadrilateral element geometries. These elements are intended for modeling very thin to moderately thick shells. Both SRI and ANS element formulations are designed to alleviate common shell element pathologies such as locking, spurous mechanisms, and mesh distortion sensitivity. However, the degree to which this is achieved varies significantly with the specific element type, and can even be problem dependent. All elements with processor ES1 are quadrilateral shell elements with 3 translational and 3 rotational freedoms per node. However, as they do not have 'drilling' stiffnesses, one of the rotational freedoms may have to be suppressed at each node, if it aligns too closely with a computational basis vector at that node. Author

N91-22596*# Lockheed Missiles and Space Co., Palo Alto, CA. Research and Development Div.
THE COMPUTATIONAL STRUCTURAL MECHANICS TESTBED STRUCTURAL-ELEMENT PROCESSOR ES5: STAGS SHELL ELEMENT
Charles Rankin and Frank Brogan Washington NASA May 1991 42 p
(Contract NAS1-18444)
(NASA-CR-4358; NAS 1.26:4358; LMSC-D878511) Avail: NTIS HC/MF A03 CSCL 20K

The theory is documented behind the CSM Testbed structural finite element processor ES5 for the STAGS shell element. Processor ES5 contains the displacement based 4 node quadrilateral shell element used as the 'workhorse' element in the STAGS code. This element is intended for modeling thin shells for which transverse shear deformation is not important. The element uses an incompatible displacement field, which features a high order (cubic) bending field and a semi-lower order (linear/cubic) membrane field. For many problems with regular geometry, the STAGS 410 element in ES5, called E410, provides rapid convergence not possible with the same number of freedoms in an element where interelement compatability is rigidly enforced. However, it does exhibit distortion sensitivity, especially due to in-plane distortion. Sensitivity to out of plane distortion (warping) is large eliminated by the generic corotational projection operator built in to the ES processor shell. The E410 is a quadrilateral

shell element with 3 translational and 3 rotational freedoms per node. This element also has 'drilling' rotational stiffness, which proves to be an advantage for problems with intersecting geometries. Author

N91-22597*# Lockheed Missiles and Space Co., Palo Alto, CA.
THE COMPUTATIONAL STRUCTURAL MECHANICS TESTBED STRUCTURAL-ELEMENT PROCESSOR ES6: STAGS BEAM ELEMENT
Shahram Nour-Omid, Frank Brogan, and Gary M. Stanley Washington NASA May 1991 38 p
(Contract NAS1-18444)
(NASA-CR-4359; NAS 1.26:4359; LMSC-D878511) Avail: NTIS HC/MF A03 CSCL 20K

The purpose of this manual is to document the theory behind the CSM Testbed structural finite element processor ES6 for the STAGS beam element. Processor ES6 contains the displacement based 2 node beam element used within the STAGS code. This element is intended for modeling slender beams, which appear either in frame structures or as stiffening elements for shell structures. In STAGS, the element is referred to as the 210 element; in CSM Testbed processor ES6, it is called E210. The E210 element in ES6 is a 2 node straight beam element with 2 translational and 3 rotational freedoms per node. It thus represents a faceted approximation when used to model curved structures. The element features a cubic transverse (bending) displacement field, and linear axial and torsional displacement fields. Hence, it is considered compatible as a stiffener element with the STAGS-410 shell element, which is implemented as element E410 in CSM Testbed processor ES5. Note that E210 does not model warping deformation due to torsion, but does have a limited transverse-shear deformation capability. Arbitrarily large rotations may be modeled with these elements by using the standard corotational utility available for all ES processors. Author

N91-22598*# Lockheed Missiles and Space Co., Palo Alto, CA.
THE COMPUTATIONAL STRUCTURAL MECHANICS TESTBED STRUCTURAL-ELEMENT PROCESSOR ES7: REVISED ANS SHELL ELEMENTS
Gary M. Stanley, K. C. Park (Colorado Univ., Boulder.), and Harold Cabiness Washington NASA May 1991 56 p
(Contract NAS1-18444)
(NASA-CR-4360; NAS 1.26:4360; LMSC-D878511) Avail: NTIS HC/MF A04 CSCL 20K

The purpose of this manual is to document the theory behind the CSM Testbed structural finite element processor ES7 for the revised ANS shell element. Processor ES7 contains revised versions of the assumed natural coordinate strain (ANS) transverse shear deformable shell elements introduced in processor ES1. Two elements are included, 4 node (bilinear) and 9 node (biquadratic) quadrilateral element geometries. These element are intended for modeling very thin to moderately thick shells. The ANS shell element formulations are designed to alleviate common shell element pathologies such as locking, spurious mechanisms, and mesh distortion sensitivity. However the distortion sensitivity problem has not yet been totally solved. Numerical experiments indicate that for curved shells, the 4 and 9 node ANS elements in processor ES7 are less distortion sensitive than those in processor ES1. However, for flat plates, the reverse seems to be true. Nevertheless, ongoing research suggests that these deficiencies can at lease be mitigated, and the simplicity of the present formulation suggests that it should lead to increased efficiency and generality with respect to the original formulation in ES1. Author

N91-22599# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
THE NONLINEAR ANALYSIS PART OF B2000: A FIRST EVALUATION
A. deBoer and E. Riks 13 Aug. 1988 51 p
(Contract NIVR-01507-N)
(NLR-TR-88109-U; ETN-91-99161) Copyright Avail: NTIS HC/MF A04

A description of the nonlinear package of B2000 is given. The set up of the continuation procedure which controls the nonlinear calculations is explained. At some points the existing continuation procedure was modified to enhance its performance. The nonlinear package contains a nonlinear rod element and a nonlinear thick shell element. Different problems were analyzed to test the nonlinear elements as well as the original and the NLR version of the continuation procedure. ESA

N91-22600*# Lehigh Univ., Bethlehem, PA.
THE SURFACE AND THROUGH CRACK PROBLEMS IN LAYERED ORTHOTROPIC PLATES Final Report
Fazil Erdogan and Binghua Wu May 1991 280 p
(Grant NAG1-713)
(NASA-CR-188188; NAS 1.26:188188) Avail: NTIS HC/MF A13 CSCL 20K

An analytical method is developed for a relatively accurate calculation of Stress Intensity Factors in a laminated orthotropic plate containing a through or part-through crack. The laminated plate is assumed to be under bending or membrane loading and the mode 1 problem is considered. First three transverse shear deformation plate theories (Mindlin's displacement based first-order theory, Reissner's stress-based first-order theory, and a simple-higher order theory due to Reddy) are reviewed and examined for homogeneous, laminated and heterogeneous orthotropic plates. Based on a general linear laminated plate theory, a method by which the stress intensity factors can be obtained in orthotropic laminated and heterogeneous plates with a through crack is developed. Examples are given for both symmetrically and unsymmetrically laminated plates and the effects of various material properties on the stress intensity factors are studied. In order to implement the line-spring model which is used later to study the surface crack problem, the corresponding plane elasticity problem of a two-bonded orthotropic plated containing a crack perpendicular to the interface is also considered. Three different crack profiles: an internal crack, an edge crack, and a crack terminating at the interface are considered. The effect of the different material combinations, geometries, and material orthotropy on the stress intensity factors and on the power of stress singularity for a crack terminating at the interface is fully examined. The Line Spring model of Rice and Levy is used for the part-through crack problem. The surface crack is assumed to lie in one of the two-layered laminated orthotropic plates due to the limitation of the available plane strain results. All problems considered are of the mixed boundary value type and are reduced to Cauchy type of singular integral equations which are then solved numerically. Author

N91-22601*# Toledo Univ., OH.
NONLINEAR STRUCTURAL ANALYSIS OF CYLINDRICAL THRUST CHAMBERS USING VISCOPLASTIC MODELS Final Report
Vinod K. Arya Jan. 1991 15 p LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by color photographs Original document contains color illustrations
(Contract NCC3-120)
(NASA-CR-185253; E-5512; NAS 1.26:185253) Avail: NTIS HC/MF A03; 5 functional color pages CSCL 20K

The results are presented of a viscoplastic stress-strain analysis of a cylindrical thrust chamber used in experiments that were designed to simulate the SSME operating conditions. The inelastic strain was calculated by using a viscoplastic model, and a quasi-three-dimensional structural analysis was performed by using a finite element program MARC. The temperatures and pressures were calculated by using the loading cycles of experiments, and these temperatures and pressures were used in the computations. The deformed shape of the component was predicted after the end of each loading cycle. The predicted shape qualitatively replicated the deformed shape of the component as observed in experiments. The results indicate that the use of viscoplastic models for structural analysis may lead to more realistic life assessments of experimental thrust chambers. Author

N91-22602# Lawrence Livermore National Lab., CA.
NIKE3D: A NONLINEAR, IMPLICIT, THREE-DIMENSIONAL FINITE ELEMENT CODE FOR SOLID AND STRUCTURAL MECHANICS
B. N. Maker Jan. 1991 119 p
(Contract W-7405-eng-48)
(DE91-009759; UCRL-MA-105268) Avail: NTIS HC/MF A06

This report provides a user's manual for NIKE3D, a fully implicit three-dimensional finite element code for analyzing the finite strain static and dynamic response of inelastic solids, shells, and beams. Spatial discretization is achieved by the use of 8-node solid elements, 2-node truss and beam elements, and 4-node membrane and shell elements. Contact-impact algorithms permit gaps, frictional sliding, and mesh discontinuities along material interfaces. Several nonlinear solution strategies are available, including Full-, Modified-, and Quasi-Newton methods. The resulting system of simultaneous linear equations is either solved iteratively by an element-by-element method, or directly by a factorization method, for which case bandwidth minimization is optional. Data may be stored either in or out of core memory to allow for large analyses. DOE

N91-22603 Tel-Aviv Univ. (Israel). Dept. of Solid Mechanics, Materials and Structures.
ELASTIC-PLASTIC ANALYSIS OF MODE 2 FRACTURE SPECIMEN M.S. Thesis
Dov Sherman Mar. 1988 185 p In HEBREW; ENGLISH summary
(ITN-91-85093) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel

The aim of this investigation is to calibrate a mode 2 fracture specimen, made of elastic-plastic (ductile) material. The study arose from tests on Al 7075 T-7351, a ductile material, in which a load vs. load lince crack sliding displacement record was obtained which is initially linear but which becomes nonlinear as the load increases. The nonlinearity appears to be cause by large-scale yielding at the crack tip, preventing the use of linear elastic fracture mechanics. In order to calculate the characteristic parameter of the stress field at the crack tip, elastic-plastic fracture mechanics should be taken into consideration. The stress and displacement fields of the mode 2 fracture specimen were computed from a finite element analysis. A computer code which uses these fields was written to determine both J(sub x) and J(sub xx), the crack tip stress field characteristic parameters, by the Rice J-integral. Results obtained by the above procedure for various mode 1 and mixed mode configurations were compared with their counterparts in the literature, and good agreement was attained. To develop a calibration function for the mode 2 fracture specimen, an approximation was sought which makes use of a rigid plastic limit analysis. This function, which permits the calculation of J(sub xx) directly from a load vs. load line crack sliding displacement curve is given by J(sub 2) = A/B(W - a) where A is the area under the curve, B is the specimen thickness, W is its width, and a is the crack length. Comparison of J(sub xx) obtained from the approximate formula and the J-integral assisted in locating a judicious position for the crack sliding gage required in a test. This formula provides a means to calculate J(sub xx) from a test record, thus enabling the determination of J(sub xx) - the critical parameter, which predicts fast unstable crack growth. ISA

N91-22604*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE DYNAMIC EFFECTS OF INTERNAL ROBOTS ON SPACE STATION FREEDOM
Jeffrey H. Miller (Sverdrup Technology, Inc., Brook Park, OH.), Charles Lawrence, and Douglas A. Rohn 1991 16 p Presented at the Guidance Navigation and Control Conference, New Orleans, LA, 12-14 Aug. 1991; sponsored by AIAA
(NASA-TM-104345; E-6119; NAS 1.15:104345; AIAA-91-2822)
Avail: NTIS HC/MF A03 CSCL 20K

Many of the planned experiments of the Space Station Freedom (SSF) will require acceleration levels to be no greater than microgravity (10 exp -6 g) levels for long periods of time. Studies have demonstrated that without adequate control, routine operations may cause disturbances which are large enough to affect on-board experiments. One way to both minimize disturbances and make the SSF more autonomous is to utilize robots instead of astronauts for some operations. The present study addresses the feasibility of using robots for microgravity manipulation. Two methods for minimizing the dynamic disturbances resulting from the robot motions are evaluated. The first method is to use a robot with kinematic redundancy (redundant links). The second method involves the use of a vibration isolation device between the robot and the SSF laboratory module. The results from these methods are presented along with simulations of robots without disturbance control. Author

42 GEOSCIENCES (GENERAL)

N91-22605*# National Aeronautics and Space Administration, Washington, DC.
NASA EARTH SCIENCE AND APPLICATIONS DIVISION: THE PROGRAM AND PLANS FOR FY 1988-1989-1990
Sep. 1988 129 p
(NASA-TM-104943; NAS 1.15:104943) Avail: NTIS HC/MF A07 CSCL 08B

Described here are the Division's research goals, priorities and emphases for the next several years and an outline of longer term plans. Included are highlights of recent accomplishments, current activities in FY 1988, research emphases in FY 1989, and longer term future plans. Data and information systems, the Geodynamics Program, the Land Processes Program, the Oceanic Processes Program, the Atmospheric Dynamics and Radiation Program, the Atmospheric Chemistry Program, and space flight programs are among the topic covered. Author

N91-22606*# National Aeronautics and Space Administration, Washington, DC.
NASA GEOLOGY PROGRAM BIBLIOGRAPHY
May 1991 96 p
(NASA-TM-4277; NAS 1.15:4277) Avail: NTIS HC/MF A05 CSCL 08G

A bibliography of scientific papers, articles, and books based on research supported by the NASA Geology Program is given. The citations cover the period 1980 to 1990. An author index is included. Author

N91-22607 Tel-Aviv Univ. (Israel). Dept. of Geophysics and Planetary Science.
THE MAGNETIC FIELD OVER THE DEAD SEA-LISAN AREA M.S. Thesis
Ehud Ram Jun. 1989 59 p In HEBREW; ENGLISH summary
(ITN-91-85098) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel

The central part of the Dead Sea graben was investigated using a variety of geophysical methods in order to study the sub-bottom structure of the Lisan area. This area, which lies between the two basins of the Dead Sea is characterized by a complex geological structure and complicated tectonic processes. Both aeromagnetic and shallow refraction seismic measurements were carried out. As a result of these measurements, a map of structural elements and high-resolution maps of magnetic anomalies were completed, giving new information about the infrastructure of the area. The aeromagnetic survey was performed with high accuracy by a helicopter whose movement was monitored in real time by a radar-controlled navigation system. The magnetic anomaly map of the raw data was prepared by reducing a regional field calculated by a two-dimensional linear regression. The magnetic anomaly map corrected by the IGRF values was then combined with the aeromagnetic anomaly maps of Israel and Jordan, and the magnetic map of the northern part of the Dead Sea. ISA

43 EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography.*

N91-22608*# Purdue Univ., West Lafayette, IN. Lab. for Applications of Remote Sensing.
NASA APPLICATIONS PROJECT IN MIAMI COUNTY, INDIANA Progress Report
R. Norberto Fernandez, D. Fabian Lozano-Garcia, Phillip J. Wyss, and Chris J. Johannsen 12 Apr. 1989 18 p
(Grant NAGw-1472)
(NASA-CR-188007; NAS 1.26:188007) Avail: NTIS HC/MF A03 CSCL 08B

The study site selection is intended to serve all of the different research areas within the project, i.e., soil conditions, soil management, etc. There are seven major soil associations or soils formed on similar landscapes in the Miami Co., and over 38 soil series that were mapped. Soil sampling was conducted in some sites because of its variability in soils and cover types, variable topography, and presence of erosion problems. Results from analysis of these soil data is presented. Author

N91-22609*# Science and Technology Corp., Hampton, VA.
SCIENCE NEEDS FOR REAL TIME ADAPTABLE DATA PRODUCTS FROM THE EARTH OBSERVING SYSTEM (EOS) Final Report
Paul D. Try, Paul F. Twitchell, and Christopher R. Redder Washington NASA May 1991 94 p
(Contract NAS1-18676)
(NASA-CR-4363; NAS 1.26:4363; STC-TR-4026) Avail: NTIS HC/MF A05 CSCL 08B

The goal is to review the potential Earth Observing System (EOS) instruments to advance the knowledge of the Earth system time dependent processes that impact global climate change research needs. Considered are the parameters to be measured, resolution, characteristics, data reduction algorithms in identifying the best EOS instruments to contribute to the research goals of the EOS program, and the need for real time adaptable products from EOS. Author

N91-22610# Army Engineer Topographic Labs., Fort Belvoir, VA.
SPECTRAL CHARACTERISTICS OF SOME SALINE PLAYA SURFACES AND THEIR APPLICATION TO MULTISPECTRAL IMAGERY ANALYSIS Scientific Paper 23 - 27 Jul. 1990
J. P. Henley 27 Jul. 1990 9 p
(AD-A231167; ETL-R-154) Avail: NTIS HC/MF A02 CSCL 20/6

Playas, commonly formed in arid basins, can have surface conditions ranging from hard and dry to soft and moist. These surfaces result from the relation between the hydrologic environment and the mineralogy of the surrounding basin. Surfaces composed of soluble salts deposited by capillary action from saline ground water can be found on playas in structurally closed basins. To determine methods of discriminating different saline mineral deposits using multispectral imagery, spectral reflectance data (400 to 2500 nm range) of selected saline playas in the Mojave Desert were collected using a portable spectroradiometer. Reflectance data included field spectra of salt crusts and laboratory spectra of pure compounds and salt mixtures. Results show that while certain common soluble materials such as potassium chloride and sodium chloride are spectrally featureless in the Landsat Thematic Mapper (TM) visible and near infrared bands, others such as calcium sulfate and calcium chloride have absorptions in TM bands 5 and 7 which allow their discrimination from other salts. Knowledge of the spectral characteristics of these materials allows selection of band combinations and ratios which maximize discrimination of different surfaces using TM multispectral imagery. GRA

N91-22611# Beleidscommissie Remote Sensing, Delft (Netherlands).
RADAR REMOTE SENSING OF TROPICAL FORESTS: A LITERARY REVIEW
J. J. vanderSanden (Wageningen Agricultural Univ., Netherlands) Nov. 1990 32 p
(BCRS Proj. AO-2.22)
(BCRS-90-05B; ETN-91-99153) Avail: NTIS HC/MF A03

A literature study concerning radar remote sensing of tropical forests is discussed. Forest backscatter as a function of wavelength, polarization, incidence angle and forest structure is considered. The development and application of forest backscatter models are looked into. Microwave sensors have the potential to observe vegetation/soil moisture and vegetation structure. Within a forest object, four scattering sources are distinguished. These and the factors affecting their relative strength and total backscattered energy are listed. They are important in modeling studies which describe the physical basis of the relationship between forest backscatter and forest structure. Longer wavelengths and smaller incidence angles enhance the penetrating capacity of microwaves. In these cases information on layers underlying the forest canopy can be expected. This phenomenon offers opportunities to distinguish between primary/secondary, disturbed/undisturbed and flooded/nonflooded forests. Microwave polarization is, apart from sensor characteristics, dominated by species composition, stand and canopy structure. As such, radar systems with an appropriate polarization, and long wavelengths, may serve as a tool for determination of tree/forest type. Radar backscatter may be considerably influenced by terrain topography. ESA

N91-22612# Beleidscommissie Remote Sensing, Delft (Netherlands).
UTILIZATION OF REMOTE SENSING IN LAND USE PRACTICE [TOEPASSING VAN REMOTE SENSING IN DE LANDINRICHTINGSPRAKTIJK]
W. J. Droesen and M. N. Jaarsma (Winand Staring Centre, Wageningen, Netherlands) Aug. 1990 82 p In DUTCH
(BCRS Proj. OP-2.3)
(BCRS-90-10; ISSN-0924-3070; ETN-91-99154) Copyright Avail: NTIS HC/MF A05

To what extent remote sensing can replace, complement, or make more efficient land use inventory methods was investigated. During several flights multispectral and radar pictures as well as false color photographs were taken at different heights. LANDSAT Thematic Mapper and SPOT satellite pictures were also used. The use of false color photographs has proved to be cost efficient but are not sufficiently used. Scanning techniques are potentially applicable. Reflection pictures provide information about land use, and heat pictures provide information about evaporation of vegetation. The main problems for the practical use of remote sensing are the availability of usable pictures, the required specialist knowledge, and the very important necessary adaptation of the present methods. ESA

44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *28 Propellants and Fuels.*

N91-22613 Cleveland State Univ., OH.
TRANSIENT THERMAL ANALYSIS OF A BRAYTON CYCLE SOLAR DYNAMIC HEAT RECEIVER Ph.D. Thesis
Kyung Hwan Ahn 1990 186 p
Avail: Univ. Microfilms Order No. DA9100862

A thermal design of solar receiver was developed for the solutions of problems involving phase-change thermal energy

storage and natural convection loss. Two dimensional axisymmetrical solidification and melting of materials contained between two concentric cylinders of finite length was studied for thermal energy storage analysis. For calculation of free convection loss inside receiver cavity, two dimensional axisymmetrical, laminar, transient free convection including radiation effects was studied using integral/finite difference method. Finite difference equations are derived for above analysis subject to constant or variable material properties, initial and boundary conditions. The validity of the analyses was substantiated by comparing results of the present general method with available analytic solutions or numerical results reported in the literature. Both explicit and implicit schemes are tested in phase change analysis with different number of nodes ranging from 4 to 18. Dissert. Abstr.

N91-22614*# Philips Labs., Inc., Briarcliff Manor, NY.
DESIGN AND FABRICATION OF A LONG-LIFE STIRLING CYCLE COOLER FOR SPACE APPLICATION. PHASE 3: PROTOTYPE MODEL Final Report, Sep. 1981 - Sep. 1990
C. Keung, P. J. Patt, M. Starr, R. C. Sweet, L. A. Bourdillon, R. Figueroa, M. Hartmann, and R. McFarlane Nov. 1990 189 p
(Contract NAS5-26688)
(PL-11-CR90-1116-Phase-3) Avail: NTIS HC/MF A09 CSCL 10B

A second-generation, Stirling-cycle cryocooler (cryogenic refrigerator) for space applications, with a cooling capacity of 5 watts at 65 K, was recently completed. The refrigerator, called the Prototype Model, was designed with a goal of 5 year life with no degradation in cooling performance. The free displacer and free piston of the refrigerator are driven directly by moving-magnet linear motors with the moving elements supported by active magnetic bearings. The use of clearance seals and the absence of outgassing material in the working volume of the refrigerator enable long-life operation with no deterioration in performance. Fiber-optic sensors detect the radial position of the shafts and provide a control signal for the magnetic bearings. The frequency, phase, stroke, and offset of the compressor and expander are controlled by signals from precision linear position sensors (LVDTs). The vibration generated by the compressor and expander is cancelled by an active counter balance which also uses a moving-magnet linear motor and magnetic bearings. The driving signal for the counter balance is derived from the compressor and expander position sensors which have wide bandwidth for suppression of harmonic vibrations. The efficiency of the three active members, which operate in a resonant mode, is enhanced by a magnetic spring in the expander and by gas springs in the compressor and counterbalance. The cooling was achieved with a total motor input power of 139 watts. The magnetic-bearing stiffness was significantly increased from the first-generation cooler to accommodate shuttle launch vibrations. Author

N91-22615# Swedish Inst. for Materials Testing, Boras. Dept. of Energy Technology.
LABORATORY TESTING OF HEAT PUMPS: EXPERIENCE 1984 - 1986
Per Fahlen 1990 92 p Sponsored by Swedish Council for Building Research, Stockholm
(PB91-135194; SP-TR-1990:19; ISBN-91-7848-225-9) Avail: NTIS HC/MF A05 CSCL 10A

Experience is presented from laboratory testing of heat pumps at the Swedish National Testing Institute during the period 1984-1986. A total of 186 heat pumps have been so far tested at the institute, 71 of which were tested during the investigation period. Comparisons between results obtained during different years show that performance data improved significantly up to 1983, there after, improvements were marginal. Tested values for coefficients of performance and heating output are on average 10-12 percent below data given by manufacturers. Remarkably large deviations are shown to exist between different makes of heat pumps, concerning coefficient of performance, heating of sanitary hot water, defrosting efficiency, and noise levels. Additional results describing how various parameters, such as flow rate, temperature, humidity, etc. affect the operation of heat pumps are presented. Author

N91-22616# Sandia National Labs., Albuquerque, NM.
GENERAL THEME REPORT: WORKING SESSION 2, SOLAR THERMAL SYSTEMS
D. J. Alpert and G. J. Kolb 1991 12 p Presented at the 1991 Solar Power Systems Conference, Yalta (USSR), 22-26 Apr. 1991
(Contract DE-AC04-76DP-00789)
(DE91-009251; SAND-91-0582C; CONF-9104123-2) Avail: NTIS HC/MF A03

Currently, over 90 percent of the world's large-scale solar electric energy is generated with concentrating solar thermal power plants. Such plants have the potential to meet many of the world's future energy needs. Research efforts are generally focused on generating electricity, though a variety of other applications are being pursued. Today, the technology for using solar thermal energy is well developed, cost competitive, and in many cases, ready for widespread application. The current state of each of the solar thermal technologies and their applications is reviewed, and recommendations for increasing their use are presented. The technologies reviewed in detail are: parabolic trough systems, central tower systems, and parabolic dish systems. DOE

N91-22617# Sandia National Labs., Albuquerque, NM.
THE DOE SOLAR THERMAL ELECTRIC PROGRAM CONCENTRATOR TECHNOLOGY PROJECT
T. R. Mancini 1991 18 p Presented at the SOLTECH 1991 Conference, Burlingame, 25-28 Mar. 1991
(Contract DE-AC04-76DP-00789)
(DE91-009253; SAND-91-0570C; CONF-9103109-1-Vugraphs)
Avail: NTIS HC/MF A03

The project comprises the development of concentrating solar collectors, heliostats, and dishes, and the development of optical materials. Because the solar concentrator represents from 40 to 60 percent of the cost of a solar thermal electric system, the continued development of high-performance concentrators is very important to the commercial viability of these systems. The project is currently testing two large area heliostats, the SPECO 200 sq m heliostat and the ATS 150 sq m heliostat, and also trying to reduce the cost of the heliostats through the development of stretched-membrane heliostats. Stretched-membrane heliostats are made by attaching thin metal membranes to the two sides of a circular, metal ring. A slight vacuum in the plenum between the two membranes is used to focus the heliostat. The optical surface is provided by a silver-acrylic film, ECP 305. A prototype 100 sq m commercial unit has been built and is currently being tested. Parabolic dish concentrators are under development for use on dish-Stirling electric systems. The state-of-the-art dish is the McDAC/SCE faceted glass concentrator. Because of the success of stretched-membrane technology for heliostats, the project applied the technology to parabolic dish development and is currently designing a near-term, faceted, stretched-membrane dish. The current thrust of the program in optical materials development is the development of a low-cost, high-performance, silver-acrylic film. 3M's ECP 305 has demonstrated substantial improvement over previous films in its resistance to corrosion and its longer life. An experimental film, developed at SERI, has promise for further improving the lifetime of the ECP 305. The project is currently investigating solutions to the problem of separation between the silver and acrylic layers of the film in the presence of water. DOE

N91-22618# International Fuel Cells Corp., South Windsor, CT.
TASK 1.0, DEVELOPMENT OF IMPROVED MOLTEN CARBONATE FUEL CELL
W. H. Johnson Oct. 1990 52 p
(Contract DE-AC21-87MC-23270)
(DE91-002055; DOE/MC-23270/2969) Avail: NTIS HC/MF A04

The overall objective of this task was to develop an improved cell configuration for molten carbonate fuel cells which has improved performance, meets a 40,000 hour projected life, maintains existing cell cost, and is adaptable to a range of power

plant applications. A new cell configuration designed to be manufactured using conventional and available equipment and processes was developed and verified in subscale single cells. This cell configuration is adaptable to a broad range of fuels without redesign, operating on very weak low Btu coal gas as well as high Btu gas and natural gas. The success of this program has provided the confidence to proceed with a scale-up to 8 sq ft. cells and a stack verification in a 20-cell, 25 kW stack test. Design requirements and specifications for components in an improved cell design were defined. Electrolyte requirements for the cell components were established, the estimated time-to-short was updated, and a design operating point and gas composition for single cell testing was defined. Four anode, four cathode, five matrix configurations, and three end-cell reservoirs were defined. A total of 54 single cell tests were conducted to evaluate the performance of individual improvements and combinations of improved configurations. Anodes were successfully fabricated by tape casting. A new tape cast cathode for improved electrolyte sharing, new tape cast matrix materials and matrix reinforcement, and an end-cell reservoir configuration using conductive material were developed. Reports on the separate subtasks have been processed for inclusion on the data base. DOE

N91-22178*# Spiral Survey Expedition, Thunder Bay (Ontario).
POLAR LUNAR POWER RING: PROPULSION ENERGY RESOURCE
Graham Scott Galloway *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 485-493 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 10B

N91-23054*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SOLAR POWERED STIRLING CYCLE ELECTRICAL GENERATOR
Richard K. Shaltens *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 269-278 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 10B

45 ENVIRONMENT POLLUTION

Includes atmospheric, noise, thermal, and water pollution.

N91-22619*# Colorado Univ., Boulder. Center for Space and Geosciences Policy.
RESEARCH IN GEOSCIENCES POLICY Year 2 Status Report, 1 Jan. - 31 Dec. 1990
Radford Byerly, Jr. and Sally McVey 1 Apr. 1991 138 p (Grant NAGw-1415)
(NASA-CR-188038; NAS 1.26:188038) Avail: NTIS HC/MF A07 CSCL 13B

Various topics related to cases of difficult adaptation to global change are discussed. Topics include patterns in the ratification of global environmental treaties, the effects of global climate change on Southeast Asia, and global change and biodiversity loss. For individual titles, see N91-22620 through N91-22623.

N91-22620*# Colorado Univ., Boulder. Dept. of Geography.
EXPLAINING PATTERNS IN THE RATIFICATION OF GLOBAL ENVIRONMENTAL TREATIES
David W. Cook *In its* Research in Geosciences Policy 1 Apr. 1991 p 5-24 (For primary document see N91-22619 14-45)
Avail: NTIS HC/MF A07 CSCL 13B

A study was made of the ratification behavior of 160 countries with respect to 38 global environmental treaties. The study identifies and explains patterns in the ratification of treaties, providing two means of assessing the likelihood that any given country will support global environmental treaties. National ratification totals reveal a pattern of high ratification by countries in Western Europe, North America, Japan, Australia, and New Zealand. A country's standing within the range of high to low ratification rates can be explained by the statistical model developed in the study. This research allows one to identify countries likely to support global environmental treaties. Author

N91-22621*# Colorado Univ., Boulder. Dept. of Economics and Environment and Behavior Program.
THE EFFECTS OF GLOBAL CLIMATE CHANGE ON SOUTHEAST ASIA: A SURVEY OF LIKELY IMPACTS AND PROBLEMS OF ADAPTATION
Sukrisno Njoto and Charles W. Howe *In its* Research in Geosciences Policy 1 Apr. 1991 p 25-63 (For primary document see N91-22619 14-45)
Avail: NTIS HC/MF A07 CSCL 13B

Study results indicate the likelihood of significant net damages from climate change, in particular damages from sea-level rise and higher temperatures that seem unlikely to be offset by favorable shifts in precipitation and carbon dioxide. Also indicated was the importance of better climate models, in particular models that can calculate climate change on a regional scale appropriate to policy-making. In spite of this potential for damage, there seems to be a low level of awareness and concern, probably caused by the higher priority given to economic growth and reinforced by the great uncertainty in the forecasts. The common property nature of global environment systems also leads to a feeling of helplessness on the part of country governments. Author

N91-22622*# Colorado Univ., Boulder. Center for Values and Social Policy.
GLOBAL CHANGE AND BIODIVERSITY LOSS: SOME IMPEDIMENTS TO RESPONSE
Karen Borza and Dale Jamieson *In its* Research in Geosciences Policy 1 Apr. 1991 p 64-107 (For primary document see N91-22619 14-45)
Avail: NTIS HC/MF A07 CSCL 13B

Discussed here are the effects of anthropogenic global climate change on biodiversity. The focus is on human responses to the problem. Greenhouse warming-induced climate change may shift agricultural growing belts, reduce forests of the Northern Hemisphere and drive many species to extinction, among other effects. If these changes occur together with the mass extinctions already occurring, we may suffer a profound loss of biological diversity. Author

N91-22623*# Colorado Univ., Boulder. Center for Space and Geosciences Policy.
A REMOTE SENSING APPLICATIONS UPDATE: RESULTS OF INTERVIEWS WITH EARTH OBSERVATIONS COMMERCIALIZATION PROGRAM (EOCAP) PARTICIPANTS
Sally McVey *In its* Research in Geosciences Policy 1 Apr. 1991 p 108-136 (For primary document see N91-22619 14-45)
Avail: NTIS HC/MF A07 CSCL 13B

Earth remote sensing is a uniquely valuable tool for large-scale resource management, a task whose importance will likely increase world-wide through the foreseeable future. NASA research and engineering have virtually created the existing U.S. system, and will continue to push the frontiers, primarily through Earth Observing System (EOS) instruments, research, and data and information systems. It is the researchers' view that the near-term health of remote sensing applications also deserves attention; it seems important not to abandon the system or its clients. The researchers suggest that, like its Landsat predecessor, a successful Earth Observing System program is likely to reinforce pressure to 'manage' natural resources, and consequently, to create more pressure for Earth Observations Commercialization (EOCAP) type applications. The current applications programs, though small, are valuable because of their technical and commercial results, and also because they support a community whose contributions will increase along with our ability to observe the Earth from space. Author

N91-22624# Biospherics Research Corp., Hillsboro, OR.
SOUTHERN CALIFORNIA AIR QUALITY STUDY. PART 1: HYDROCARBON COLLECTION AND ANALYSES; AND PART 2: AIR TOXICS COLLECTION AND ANALYSES Final Report
R. A. Rasmussen Mar. 1990 29 p
(Contract ARB-A6-179-32)
(PB91-129353; ARB-R-90/448) Avail: NTIS HC/MF A03
CSCL 13B

As part of the 1987 Southern California Air Quality Study (SCAQS), 735 stainless steel canisters were provided for collection and analysis of ambient speciation hydrocarbons. One-hour integrated samples were collected in 6 L electropolished stainless steel canisters at all SCAQS 'B' sites (9 sites during the summer and 6 sites during the fall) at 0700, 1200, and 1600 PST. Additional smaples were collected at 0500, 0900, and 1400 PST at Claremont and Long Beach during the summer, and at downtown Los Angeles and Long Beach in the fall. A total of 473 samples were collected from the surface sampling sites during the study. An additional 250 samples were collected aloft aboard aircraft in 3.2 L canisters. The samples were analyzed for individual C4 to C12 hydrocarbons by the Environmental Protection Agency. Analysis was provided for CO, CH4, and C2 to C12 hydrocarbons for all samples and analysis of C4 to C12 hydrographs for 10 percent of the samples for purposes of quality assurance. AeroVironment also collected 64 24-hour integratred samples in 15 L electropolished stainless steel canister at Claremont, downtown Los Angeles, Long Beach, and Rubidoux. These samples were analyzed for the following toxic air contaminants: benzene; o-, m-, p-xylene; and ten halogenated hydrocarbons. Author

N91-22625# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
REMOTE SENSING AND LIMNOLOGY: PRELIMINARY STUDIES OF THE UHE-TUCURUI RESERVOIR
Evlyn Marcia Leao deMoraesNovo and Jose Salatiel Pires (Eletronorte, Brasilia, Brazil) Nov. 1990 13 p Presented at the 6th Brazilian Symposium on Remote Sensing, Manaus, 24-29 Jun. 1990
(INPE-5181-PRE/1650) Avail: NTIS HC/MF A03

Some preliminary results of studies which are being performed in the Tucurui reservoir through scientific cooperation between the Institute for Space Research and the Brazilian Northern Electric Company (Eletronorte) are presented. Total Suspended Solids (TSS) gradients derived from water samples along three limnological stations are compared to gradient in digital counts taken from TM/Landsat data at three different dates. These preliminary results indicate that the spectral radiance detected by TM/Landsat data is sensitive to changes in TSS greater than 4 mg/l. This difference represents the average TSS concentration between two adjacent limnological stations (M5 and M4) in the dry season. Hydrodynamical factors are controlling a high rate of sediment depositon at the reservoir entrance and/or the submersion of Tocantins denser water towards the metalimnium. More studies are needed so as to understand the factors controlling the TSS gradients at the reservoir entrance and their consequences to the equilibrium of the aquatic system. Author

N91-22626# California Univ., Berkeley. Lawrence Berkeley Lab.
CONCENTRATIONS OF INDOOR POLLUTANTS (CIP) DATABASE USER'S MANUAL (VERSION 4.0)
M. G. Apte, S. R. Brown, C. A. Corradi, S. P. Felix, D. T. Grimsrud, B. V. Smith, G. W. Traynor, and A. L. Woods Oct. 1990 40 p
(Contract DE-AC03-76SF-00098)
(DE91-009115; LBL-Pub-3083) Avail: NTIS HC/MF A03

This is the latest release of the database and the user manual. The user manual is a tutorial and reference for utilizing the CIP Database system. An installation guide is included to cover various hardware configurations. Numerous examples and explanations of the dialogue between the user and the database program are provided. It is hoped that this resource will, along with on-line help and the menu-driven software, make for a quick and easy learning curve. For the purposes of this manual, it is assumed that the user is acquainted with the goals of the CIP Database, which are: (1) to collect existing measurements of concentrations of indoor air pollutants in a user-oriented database and (2) to provide a repository of references citing measured field results openly accessible to a wide audience of researchers, policy makers, and others interested in the issues of indoor air quality. The database software, as distinct from the data, is contained in two files, CIP. EXE and PFIL.COM. CIP.EXE is made up of a number of programs written in dBase III command code and compiled using Clipper into a single, executable file. PFIL.COM is a program written in Turbo Pascal that handles the output of summary text files and is called from CIP.EXE. Version 4.0 of the CIP Database is current through March 1990. DOE

N91-22975*# Institute of Space Research, Moscow (USSR).
THE ROLE OF IMPACTING PROCESSES IN THE CHEMICAL EVOLUTION OF THE ATMOSPHERE OF PRIMORDIAL EARTH
Lev M. Mukhin and M. V. Gerasimov *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 203-217
(For primary document see N91-22960 14-90)
Avail: NTIS HC/MF A14 CSCL 13B

N91-22977*# Pennsylvania State Univ., University Park.
RUNAWAY GREENHOUSE ATMOSPHERES: APPLICATIONS TO EARTH AND VENUS
James F. Kasting *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 234-245 (For primary document see N91-22960 14-90)
Avail: NTIS HC/MF A14 CSCL 13B

N91-23071*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
MONITORING AND CONTROL OF ATMOSPHERE IN A CLOSED ENVIRONMENT
R. Humphries and J. Perry *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 413-420 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13B

46 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation.*

N91-22627*# California Univ., Los Angeles. Inst. of Geophysics and Planetary Physics.
PHYSICS OF HEAVY IONS (1989-1990) Final Report
M. Ashour-Abdalla 21 Mar. 1991 10 p
(Grant NAG8-795)
(NASA-CR-188013; NAS 1.26:188013) Avail: NTIS HC/MF A02
CSCL 04A

The results from studies on polar wind ion heating due to kinetic ion beam instabilities and the effects of such ion heating on the outflow of O(+) in the polar wind are presented and discussed. First, the linear instabilities associated with an O(+) and H(+) polar wind plasma in the presence of O(+) and H(+) beams for a range of O(+)/H(+) beam densities, T(sub e)/T(sub i), and ion beam speeds were examined. Then, nonlinear heating of the polar wind ions was studied, using numerical simulations. The O(+) and H(+) polar wind ions were modeled by isotropic Maxwellian distributions, and the electrons, O(+) beams, and H(+) beams were modeled by drifting Maxwellian distributions. The effects of the kinetic ion heating on the outflow of the polar wind ions were examined from the ionosphere, using a time-dependent hydrodynamic model. A numerical code to solve the O(+) and H(+) continuity and momentum equations in a flux tube from ionospheric to magnetospheric altitudes were developed. The effects of ion heating were included by allowing for the altitudinal variation of the ion temperatures in the momentum equation. The ion temperature profiles were specified based on the ion heating

characteristics found from previous kinetic simulations. It was assumed that heating occurred above 1500 km and increased to a saturated value of temperature that was obtained directly from the kinetic simulation study. The characteristics of the dynamical polar wind without ion heating were studied, and a flux tube on closed field lines that suddenly became open at t = 0 was simulated. Then, the effects of ion heating were included. To gain some physical insight, two limiting cases were considered: preferential H(+) heating and preferential O(+) heating. How O(+) heating can lead to enhanced polar wind O(+) fluxes in the polar magnetosphere is shown. Author

N91-22628*# Dartmouth Coll., Hanover, NH. School of Engineering.
INVESTIGATION OF TURBULENT PROCESSES IN MAGNETOSPHERIC BOUNDARY LAYERS Final Technical Report, 1 Sep. 1987 - 28 Feb. 1990
William Lotko and B. U. O. Sonnerup 1990 9 p
(Grant NAGw-1169)
(NASA-CR-188009; NAS 1.26:188009) Avail: NTIS HC/MF A02 CSCL 04A

A self-consistent non-evolving two dimensional slab model of a viscous low-latitude boundary layer (LLBL) coupled to the ionosphere was developed by Phan, et al., (1989). Numerical results from the model and possible use of observations to determine the model parameters are discussed. The dynamical model developed by Lotko, et al., (1987) was used by Lotko and Shen (1991) to examine dynamical processes relevant to the LLBL with particular application to post-noon auroral shear layers. Initial results from a magnetohydrodynamic study of flank-side mangetopause boundary configuration are described. Effects of compressibility, scalar viscosity, and electrical resistivity are included in the MHD equations. B.G.

N91-22629*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THE COMBINED RELEASE AND RADIATION EFFECTS SATELLITE (CRRES) PROGRAM: A UNIQUE SERIES OF SCIENTIFIC EXPERIMENTS
David L. Reasoner, Morgan W. McCook, ed., and William W. Vaughan, ed. (Alabama Univ., Huntsville.) 1990 28 p Prepared in cooperation with Space Systems Div. AFSC Field Office, Houston, TX Original contains color illustrations
(Contract NAS8-36955)
(NASA-TM-103380; NAS 1.15:103380) Avail: NTIS HC/MF A03; 17 functional color pages CSCL 04A

The Defense Department and NASA have joined in a program to study the space environment which surrounds the earth and the effects of space radiation on modern satellite electronic systems. The Combined Release and Radiation Effects Satellite (CRRES) will carry an array of active experiments including chemical releases and a complement of sophisticated scientific instruments to accomplish these objectives. Other chemical release active experiments will be performed with sub-orbital rocket probes. The chemical releases will 'paint' the magnetic and electric fields of earthspace with clouds of glowing ions. Earthspace will be a laboratory, and the releases will be studied with an extensive network of ground-, aircraft-, and satellite-based diagnostic instruments. Some of the topics discussed include the following: the effects of earthspace; the need for active experiments; types of chemical releases; the CRRES program schedule; international support and coordinated studies; photographing chemical releases; information on locating chemical releases for observation by the amateur; and CRRES as a program. Author

N91-22630# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
APPLICATION OF REMOTE SENSING DATA INTEGRATED WITH A DIGITAL ELEVATION MODEL IN THE GEOBOTANICAL RESEARCH IN THE CARAJAS MOUNTAINS [APLICAO DE DADOS DE SENSORES REMOTOS INTEGRADOS COM MODELO DIGITAL DE ELEVACAO NA PESQUISA GEOBOTANICA NA SERRA DOS CARAJAS]
Waldir Renato Paradella, Manoela F. FernandesdaSilva, Nelson deARosa, and Joao Luiz Gouvea (Rio Doce Geologia e Mineracao S.A., Belem, Brazil) Nov. 1990 12 p In PORTUGUESE; ENGLISH summary Presented at the 36th Brazilian Conference on Geology, Natal, Brazil, 28 Oct. - 1 Nov. 1990
(INPE-5189-PRE/1657) Avail: NTIS HC/MF A03

A Geobotany approach was applied for geological exploration in the Archean metavolcanic Pojuca Belt, Carajas Province. The test site is characterized by rugged topography, thick latosol profiles and almost absence of bedrock outcrops. The vegetation is typical pf tropical rainforests with a complex canopy and a great variety of species. The analysis focussed on community level and was tested through digital image processing of orbital RS(TM-LANDSAT) and DEM data. The first results of the research showed that 11 RS biophysical classes were detected; the majority with good spatial correlations with previous geological units. Author

N91-22631*# International Council of Scientific Unions, Urbana, IL. Middle Atmosphere Program.
HANDBOOK FOR MAP, VOLUME 32. PART 1: MAP SUMMARY. PART 2: MAPSC MINUTES, READING, AUGUST 1989. MAP SUMMARIES FROM NATIONS. PART 3: MAP DATA CATALOGUE
R. A. Vincent, ed., B. Edwards, ed., and I. Hirota, ed. Jan. 1991 217 p
(NASA-CR-188151; NAS 1.26:188151) Avail: NTIS HC/MF A10 CSCL 04A

Extended abstracts from the fourth workshop on the technical and scientific aspects of mesosphere stratosphere troposphere (MST) radar are presented. Individual sessions addressed the following topics: meteorological applications of MST and ST radars, networks, and campaigns; the dynamics of the equatorial middle atmosphere; interpretation of radar returns from clear air; techniques for studying gravity waves and turbulence, intercomparison and calibration of wind and wave measurements at various frequencies; progress in existing and planned MST and ST radars; hardware design for MST and ST radars and boundary layer/lower troposphere profilers; signal processing; and data management. Author

N91-22632 Oxford Univ. (England).
KINETIC STUDIES OF ATMOSPHERIC REACTIONS Ph.D. Thesis
I. W. Hall 1988 194 p
Avail: Univ. Microfilms Order No. BRD90461

Experiments to measure the rate coefficients for some reactions of atmospherically important radicals are described. The discharge flow technique couples with resonance fluorescence detection of OH was used to measure the rate constants for the reactions of OH radicals with molecular chlorine and bromine in the following reactions: (1) OH + Cl2 yields HOCl + Cl; and (2) OH + Br2 yields HOBr + Br. Rate constants were obtained at room temperature that were in agreement with previous results. The temperature dependence of the first reaction was found to be described by an Arrhenius expression, and for the second reaction, the results show greater scatter, so that the error limits associated with the Arrhenius parameters are large. Calculation of the collision frequency factor for the reaction of OH and Br2 allows more realisitc estimates of E(sub A) and A to be made. The discharge flow/resonance fluorescence technique was also used to determine the temperature dependences of OH + alkyne reactions. A possible pressure dependence of the interaction of OH with propyne was investigated with the constraints imposed by the use of a fast-flow apparatus; no variation of the rate constant with pressure was observed over the range 1.7 to 6.4 mmHg. The relative reactivity of the alkynes is discussed with both OH and NO3, and similar behavior is found in the reactions of the alkenes with OH, O, and NO3. Molecular modulation spectroscopy was used to measure the rate constant for the reaction HO2 + NO3 yields products. The temperature dependence of this reaction was studied. The absorption cross section of the nitrate radical is an important parameter in atmospheric monitoring and modeling, and in experimental measurements of NO3 concentration. Experiments

performed using the molecular modulation apparatus in single-shot mode gave a value which agrees with the majority of published results. Other results from the investigation are presented.
Dissert. Abstr.

N91-22633 Minnesota Univ., Minneapolis.
STRATOSPHERIC AND LABORATORY STUDIES OF OZONE ISOTOPE FRACTIONATION Ph.D. Thesis
Beth Ann Schueler 1990 83 p
Avail: Univ. Microfilms Order No. DA9100974

Ozone measurements in both the stratosphere and in laboratory experiments have revealed an unusual fractionation of the rare, heavy isotopes. Stratospheric observations indicate that the ozone isotope, (50)O3, is sometimes enriched by as much as 40 percent relative to the most abundant isotope, (48)O3, while ozone generated in the laboratory has shown an enhancement in (50)O3 of 10 to 15 percent. To date, this effect remains unexplained. Present statospheric measurements of ozone isotopes are extended, and properties of heavy ozone enrichment are further characterized with several laboratory experiments. The goal is to aid in the development of a comprehensive, quantitative theory that explains the process resulting in heavy ozone enrichment and provides a better understanding of the ozone formation mechanism in general. A stratospheric ozone sample collection system was developed to obtain measurements of ozone isotopes by condensing an ozone sample which is returned to the laboratory for mass spectrometer analysis. This system provides an independent verification of stratospheric heavy ozone enrichment with precise measurement of (50)O3 and (49)O3. An analysis of six collected ozone samples was performed and the results are presented. Two laboratory experiments were also performed to study ozone isotope fractionation. The first investigation measured the dependence of heavy ozone enhancement on total pressure, using electric discharge in O2 to form ozone. A second experiment further investigates ozone isotope enrichment by generating all possible ozone isotopes from mass 48 to 54 with isotopically labeled oxygen. The results of these two experiments are also presented. Dissert. Abstr.

N91-22634 Iowa State Univ. of Science and Technology, Ames.
THE EFFECT OF ATMOSPHERIC DIABATIC HEATING ON LOW-FREQUENCY OSCILLATIONS Ph.D. Thesis
Ming-Cheng Yen 1990 136 p
Avail: Univ. Microfilms Order No. DA9101386

A diagnostic scheme is devised to illustrate a chain relationship between diabatic heating and planetary-scale divergent and rotational circulations. The scheme consists of the velocity-potential maintenance equation, which relates diabatic heating and velocity potential, and the streamfunction budget equation, which depicts the streamfunction tendency caused by the imbalance between streamfunction tendencies induced by vorticity advection and source. The proposed scheme is employed to examine the effect of tropical diabatic heating on the annual variation of subtropical jet streams. It was found that annual variations of both tropical diabatic heating and planetary-scale divergent circulation exhibit an annual in-phase seesaw oscillation between the winter and summer hemispheres. The annual variation of subtropical jet streams is caused by the adjustment of atmospheric rotational flow through planetary-scale divergent circulation in response to the annual cycle of tropical diabatic heating. Dissert. Abstr.

N91-22635# California Univ., Los Angeles.
INTRASEASONAL OSCILLATIONS IN THE EARTH-ATMOSPHERE SYSTEM Ph.D. Thesis
Steven Leonard Marcus 1990 26 p
Avail: NTIS HC/MF A03

Intraseasonal fluctuations in the earth's angular momentum budget are studied using 12-year overlapping records of length-of-day (LOD) variations from the Jet Propulsion Laboratory and atmospheric angular momentum (AAM) data from the National Meteorological Center (NMC), as well as the result of three-year (with mountains) and on-year (without mountains) perpetual January simulations of the global atmosphere, performed with the UCLA General Circulation Model (GCM). Two distinct oscillations, with periods of 50 and 40 days, are found in the observed series of LOD and global AAM. Regional analysis of the NMC data shows that the stronger 50-day oscillations arises from zonal wind variations in the tropics, presumably associated with the Madden-Julian (MJ) oscillation, while the 40-day oscillation originates in the Northern Hemisphere (NH) extratropics. Evidence of tropical-extratropical interaction in the 36-60 day band, especially prominent in a case study of the strong global oscillations occurring in early 1988, is derived from auto-spectral and cross-spectral analysis of the AAM data by latitude. A 42-day AAM oscillation arises in the NH extratropics of the three-year GCM run, characterized by a 300-day amplitude fluctuation cycle which strongly resembles that found in the the same region from the NMC data. A barotropic, zonally-symmetric oscillation occurs in the model tropics, driven by mass exchange with the NH extratropics; localized tropical-extratropical teleconnections are also found. A standing, wavenumber-two oscillation occurring at 500 mb in the NH extratropics was found to undergo tilted-trough vacillation in conjunction with the model's AAM cycle. During the extreme phases of the AAM oscillation, the height anomalies tilt southwest-northeast, generating little net mountain torque, while during the phases of rapid AAM change, they tilt northwest-southeast, producing strong mountain torques over the Rockies and Himalayas. Author

N91-22636# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
A TWO-DIMENSIONAL PHOTOCHEMICAL MODEL OF THE TROPOSPHERE M.S. Thesis
Meade W. Carlson 1990 115 p
(AD-A231163; AFIT/CI/CIA-90-147) Avail: NTIS HC/MF A06
CSCL 04/1

An experiment using a time-dependent, two-dimensional photochemical model of the troposphere to model the vertical and zonal distribution of ozone and its precursors is presented. The experiment examines two cases. Case I simulates vertical transport due to diffusion and zonal transport due to advection, with surface emissions of ozone precursors in the center of the model domain representing an urban environment with light wind conditions favorable for the formation of ozone in concentrations greater than 80 parts per billion by volume (ppbv). In Case II, an elevated source of ozone and its precursors is introduced at the upstream boundary in order to investigate the role of advection of these chemical species on ozone concentrations. The first simulation produces surface ozone concentrations greater than 120 ppbv in the air above the urban area, and the second simulation produces an increase of 3 to 10 percent in this region. A comparison of Case I and Case II results shows that enhanced photochemical production of ozone due to the addition of ozone's precursors play an important role in this increase. GRA

N91-22637# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
MODIFICATIONS TO MCNP, VERSION 3B: INCORPORATING A VARIABLE DENSITY ATMOSPHERE, ADDENDUM
David L. Monti and Kirt A. Mathews Mar. 1991 75 p
(AD-A231425; AFIT/EN-TR-91-2-Add) Avail: NTIS HC/MF A04
CSCL 12/5

MCNP version 3B was modified to incorporate a continuously variable density atmosphere. This was accomplished by representing the variation of air density as a function of altitude with a series of continuous piecewise exponential curves up to a maximum altitude of 1000 km. User-written subroutines and functions were written which incorporated these piecewise functions. These subroutines and functions were subsequently incorporated into a production version of MCNP. Several MCNP subroutines and files were modified in support of these modifications. This report discusses detailed information regarding the theoretical development of the variable density model, the user written subroutines and functions, the modifications to MCNP subroutines and files, and other relevant information. GRA

N91-22638# Air Force Inst. of Tech., Wright-Patterson AFB, OH.

SHORT-RANGE FORECASTING USING A ONE-DIMENSIONAL PLANETARY BOUNDARY LAYER MODEL M.S. Thesis

Thomas J. Borland 1990 103 p

(AD-A231704; AFIT/CI/CIA-90-149) Avail: NTIS HC/MF A06 CSCL 04/2

An investigation of a 1-D planetary boundary layer model is performed to test its ability to accurately predict temperature and dew point temperature for a 12 hour period. The model is initialized using upper air sounding data on three separate cases. For each case, four experiments are run to determine which parameters are most critical in providing the best forecast results. These tests include changing the values of soil moisture, running the model with a different soil type and lowering the value of the writing point. The default parameter tests showed extremely good results for temperature; however, the results for dew point temperature were highly variable and quite often poor. This motivated the development of an antecedent retention index (ARI) to compute soil moisture. The test performed with the ARI improved the dew point temperature forecasts dramatically. Also examined are the sensitivity of boundary layer height, cloud cover, and model surface energy balance output to soil moisture content. The models temperature and dew point temperature forecasts could be used for air mass thunderstorm forecasting. Future applications of the model include the incorporation of vertical velocity and the advection of temperature, moisture and momentum from software available at Florida State University. GRA

N91-22639# Air Force Inst. of Tech., Wright-Patterson AFB, OH.

A STUDY OF LOCALIZED MOMENTUM FORCING IN THE THERMOSPHERES M.S. Thesis

Steven W. Lehr 1990 103 p

(AD-A231736; AFIT/CI/CIA-90-130) Avail: NTIS HC/MF A06 CSCL 04/1

The response of the neutral atmosphere to momentum forcing at F-region heights (about 400 km) is investigated. The appropriate form of the momentum equations as it pertains to the observed local acceleration of the wind at a specified location is developed. Experiments were performed using data generated by a thermospheric general circulation model (TGCM). The acceleration of the neutral wind at several locations and times were compared with the sum of the forcing terms of the momentum equation. The appropriate forms of the equation for stationary as well as moving observers were used, the latter being applied to satellites orbiting at thermospheric altitudes. The momentum equation was analyzed to determine which forces could be calculated solely from the data typically gathered by the Dynamics Explorer (DE-2) satellite Both synthesized and actual satellite data were used in the various experiments. Techniques and software were developed to assist in the data handling and subsequent analysis. The results ranged from excellent agreement between the observed acceleration and total forcing for the case of a fixed observer when archived TGCM data was used, to virtually no correlation between measured momentum forcing and observed acceleration in the case of the satellite-borne measurements. It was found that the best results were obtained when the effect of ion drag on the neutral wind was at a minimum. GRA

N91-22640# Science Applications International Corp., Arlington, VA. Center for Seismic Studies.

ANALYSIS OF HIGH FREQUENCY SEISMIC DATA Report, for 1 Oct. 1988 - 1 Oct. 1989

Hans Israelsson, Anne Suteau-Henson, and Alan Ryall 1 Oct. 1990 161 p

(Contract F19628-88-C-0159)

(AD-A231804; SAIC/CSS-TR-C89-01; GL-TR-90-0299; SR-1)

Avail: NTIS HC/MF A08 CSCL 17/10

Seimic events are detected, located, and identified using high frequency seismic data. Data for these studies come primarily from the NORESS small aperture array in Norway and its high frequency (up to 125 Hz) central element, and the high-frequency stations installed close to the Eastern Kazakhstan test sites. An examination is made of the NORESS data to be used. Mining is found to be a major source of seismic signal in Fennoscandia with large concentrations of activity on the Kola Peninsula, Southern Norway, and Central Sweden. A method is developed for estimating the rolloff and scaling parameter for corner frequency-seismic moment from spectral ratios of a suite of events from the same location and with the same source function. Studies are made of the characterization of earthquakes and mine blasts. Inter-event correlation of mine blasts is shown to constrain the relative locations of events to very small distances (100 m at 15 Hz). The effect of scatter in the delays of ripple fired quarry blasts are examined theoretically and illustrate that a 20 pct. scatter can significantly attenuate the secondary harmonics of the spectrum and reduce the signal-to-noise ratio of the primary peak. The final section is a short note on the instrument responses of the NRDC stations and the Special Data Collection System used to monitor the Nevada test site. Because the response of the two systems are similar in the teleseismic frequency band (1 to 3 Hz) magnitudes obtained from the two different systems can be compared in a gross sense. GRA

N91-22641# Air Force Environmental Technical Applications Center, Scott AFB, IL.

RANGE REFERENCE ATMOSPHERE, NELLIS

Dec. 1990 152 p

(AD-A231926; USAFETAC/PR-90/008) Avail: NTIS HC/MF A08 CSCL 04/1

This range reference atmosphere (RRA) is a statistical model (derived from upper air observations) of the atmosphere from 0 to 30 km over the Nellis range complex. The data used to create this document was from Desert Rock (KDRA), about 50 NM west Nellis AFB. The RRA provides tabulations of monthly and annual means, standard deviations, and skewness coefficients for wind speed, pressure, temperature, density, water vapor pressure, virtual temperature, and dew point temperature. It also gives means and standard deviation for the zonal and meridional wind components and hydrostatic model atmosphere. Methodology is included, along with graphic displays of wind statistics that can be derived from the wind data. GRA

N91-22642# Technische Univ., Eindhoven (Netherlands). Dept. of Physics.

MEDIUM SCALE IRREGULARITIES IN THE IONOSPHERIC ELECTRON CONTENT Ph.D. Thesis

Petrus Franciscus J vanVelthoven 1990 251 p Sponsored by Netherlands Organization for Applied Scientific Research TNO, Delft Prepared in cooperation with Royal Netherlands Meteorological Inst., The Hague

(ETN-91-99183) Avail: NTIS HC/MF A12

Observed variations in pathlength of radio signals from cosmic sources and polar orbiting satellites are discussed. The upper atmosphere is described and the basic properties of acoustic gravity waves are derived theoretically and examples valid at ionospheric heights are given. The classification of Travelling Ionospheric Disturbances (TIDs) is given and the relationship between acoustic gravity waves in the neutral atmosphere and the corresponding perturbations in the electron density in the ionospheric F region is described. The use of radio interferometric observations and differential Doppler shift measurements to study the ionospheric total electron content is described. A climatological analysis of medium scale TIDs, based on 5500 radio interferometric observations, is given. An application of the differential Doppler technique to observations made with an east west chain of these satellite signal receivers at distances of 109 and 285 km in France is described. The importance of various sources of medium scale TIDs is discussed. ESA

N91-22643# Swedish Inst. of Space Physics, Kiruna.

KIRUNA GEOPHYSICAL DATA: DATA SUMMARY 90/4-6, APRIL - JUNE 1990

Sheila Kirkwood, ed. 1990 48 p

(PB91-135913; ISSN-0453-9478) Avail: NTIS HC/MF A03 CSCL 04A

A collection of results of ground-based more or less continuous measurements of upper atmosphere variables carried out at the Swedish Institute of Space Physics is presented. The objective of this data summary is to present current geophysical data, related to polar upper atmospheric conditions, to those who require it for their research work. GRA

N91-22644# Swedish Inst. of Space Physics, Kiruna.
KIRUNA GEOPHYSICAL DATA: DATA SUMMARY 90/1-3, JANUARY - MARCH 1990
Sheila Kirkwood, ed. 1990 52 p
(PB91-135921; ISSN-0453-9478) Avail: NTIS HC/MF A04 CSCL 04A

A collection of results of ground-based more or less continuous measurements of upper atmosphere variables carried out at the Swedish Institute of Space Physics is presented. The objectives of this data summary is to present current geophysical data, related to polar upper atmospheric conditions, to those who require it for their research work. The following ground measurements of upper atmospheric parameters were conducted at the institute in the period for which data is presented: geomagnetism, optical aurora, and ionospheric ionization. GRA

N91-22645# National Geophysical Data Center, Boulder, CO.
SOLAR-GEOPHYSICAL DATA NUMBER 555, NOVEMBER 1990. PART 1 (PROMPT REPORTS): DATA FOR OCTOBER, SEPTEMBER 1990, AND LATE DATA
Helen E. Coffey, ed. Nov. 1990 170 p
(PB91-136135; SGD-555-Pt-1) Avail: NTIS HC/MF A08 CSCL 04A

In addition to a detailed index for 1990, this prompt report provides data for October 1990 on: alert periods, international sunspot numbers, daily solar indicies, smoothed sunspot numbers, observed and one-year-ahead predicted sunspot numbers, solar flares, intervals of no flare patrol observation, west solar scans, solar radio emission, and Stanford mean solar magnetic field. It also provides data for September 1990 on: solar active regions, sudden ionospheric disturbances, solar radio spectral observations, and geomagnetic indices. Late data is also presented that cover solar radio spectral observations of Culgoora for July - Aug. 1990 and geomagnetic indices. GRA

N91-22646# National Geophysical Data Center, Boulder, CO.
SOLAR-GEOPHYSICAL DATA NUMBER 555, NOVEMBER 1990. PART 2 (COMPREHENSIVE REPORTS): DATA FOR MAY 1990 AND MISCELLANEOUS
Helen E. Coffey, ed. Nov. 1990 104 p
(PB91-136143; SGD-555-Pt-2) Avail: NTIS HC/MF A06 CSCL 04A

In addition to an index for 1990, data are provided for May 1990 on: solar flares, solar radio bursts at fixed frequencies, solar x ray radiation from GOES Satellite, mass ejections from the sun, and active prominences and filaments. Miscellaneous data is presented that includes Meudon Carte Synoptic Rotations 1822-1823 (November - December 1989). GRA

N91-22647 Tel-Aviv Univ. (Israel). Dept. of Geophysics and Planetary Sciences.
A ONE-LEVEL MODEL FOR SIMULATING SURFACE WINDS OVER A COMPLEX TERRAIN M.S. Thesis
Rachel Zak-Rosenthal 1988 91 p In HEBREW; ENGLISH summary
(ITN-91-85095) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel

The aim was to evaluate the use of a 1-level mesoscale model to perform mesoscale simulation over Israel, with a high-resolution, 5 km grid. Use of 3-D models is difficult, owing to the size of the computer resources required. A coordinate system was used in which the vertical pressure coordinate was substituted by a normalized dimensionaless pressure; this enables the surface to become a coordinate surface, regardless of its complexity. Numerical aspects of the model are presented, and the results of the average summer flow obtained from the 1-level high-resolution model are presented and compared with observed values. The average summer flow from the 1-level model failed to advance the Mediterranean sea breeze. An experiment in which the diabatic force in the Dead Sea and Lake Kinnereth was multiplied showed some improvement in advancing the sea breeze into the center of the Jordan Rift Valley (JRV); an additional diagnostic equation for the layer of topographic influence also improved the results for the average summer blow, but the sea breeze front was still delayed in the south of the JRV. This confirms that the sea breeze penetration could not be fully simulated by a 1-level model. Comparison of model results with observations for four synoptic situations in Israel, at different seasons, showed that the 1-level model can be useful for various applications which require operative short-range predictions of surface flow over a complex terrain. ISA

47 METEOROLOGY AND CLIMATOLOGY

Includes weather forecasting and modification.

N91-22648# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
MESOSCALE CONVECTIVE COMPLEXES IN THE WESTERN PACIFIC REGION M.S. Thesis
David T. Miller Dec. 1990 83 p
(AD-A231159; AFIT/CI/CIA-90-143) Avail: NTIS HC/MF A05 CSCL 04/2

This thesis presents a 1983-85 study of mesoscale convective complexes (MCC's) over the Western Pacific region (WPR) using full-disc enhanced infrared (EIR) satellite imagery from the Japanese Geostationary Meteorological Satellite (GMS). Using Western Hemisphere MCC studies as a guide, MCC criteria were defined for the Western Pacific Ocean. Criteria were based on the size of the cold cloud shield, the GMS EIR curve, duration of the system, and temporal resolution of the imagery. A computer algorithm was developed which transformed cold cloud shield areas on satellite images into physical space, i.e., into actual areas in sq km. Only systems without extreme look angles, i.e., systems located between 90 deg E and 170 deg W, were used to calculate typical properties of WPR MCCs. Despite satellite problems in 1984, 206 systems met the criteria for an MCC occurrence. From this database, WPR MCC characteristics (life cycle, duration, cold cloud shield size, etc.) were calculated. The results indicate that WPR MCCs display many of the same characteristics as those found in the Americas. It is concluded that the strong similarity of the properties and environment of WPR MCCs to that in the Americas indicates that they are essentially the same phenomenon. Their high frequency in the Americas and the WPR makes them potentially important contributors to the global hydrologic cycle. GRA

N91-22649# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
MODEL PERFORMANCE DURING EXPLOSIVE CYCLOGENESIS FOR TWO COLD SEASONS M.S. Thesis
Dale R. Lasher 1990 95 p
(AD-A231162; AFIT/CI/CIA-90-148) Avail: NTIS HC/MF A05 CSCL 04/2

Analyses and forecasts from the National Meteorological Center (NMC) were examined over two cold seasons to find forecast errors during explosive and moderate cyclogenesis over the region bounded by 25 and 60 degrees north and by 90 degrees west and the eastern edge of the nested grid model (NGM) display. An explosive cyclone was defined as any cyclone which deepened at least one bergeron during any 24 hr period, while any cyclone which deepened between .5 and 1 bergeron was defined a moderate cyclone. There were 53 explosive and 43 moderate cyclones found during the study. The mean central pressure errors for the NGM 24 and 48 hr forecasts following the maximum 24 hr deepening were 6.2 and 12.5 mb respectively, while the

corresponding errors for the moderate cyclones were 2.5 and 6.0 mb. The correlations between the predicted and analyzed deepening rates were higher for the explosive cyclones. The NGM forecasts of both the explosive and moderate cyclones showed a significant southwest bias which grew with time. The bias was due to the NGM forecasting the cyclones to move too slowly. The performance of the NGM to forecast explosive cyclogenesis events in terms of the critical success index (CSI) has not changed much over the last three years. The CSI scores for the 24, 36, and 48 hr forecasts were .62, .53, and .43 respectively. The correlation between the predicted and analyzed 12 hr deepening rates during explosive cyclogenesis improved slightly over those reported in previous studies. GRA

N91-22650# Air Force Geophysics Lab., Hanscom AFB, MA.
AUTOMATED CLOUD TYPING USING SATELLITE IMAGERY
Rupert S. Hawkins and Robert P. DEntremont 14 Dec. 1990 7 p
(AD-A231419; GL-TR-90-0326) Avail: NTIS HC/MF A02 CSCL 04/2

An automated cloud typing algorithm is presented and described whereby 1 km visible and infrared Defense Meteorological Satellite Program (DMSP) data are classified into one of 18 cloud types, including clear. The cloud typing algorithm first converts a satellite visual image into a one-bit binary image that has pixel values at one of two possible grayshades. Spectral and spatial information from the original image is retained in this process; once the one-bit image is constructed it is then analyzed for features that relate to the spatial variations of the clouds in the original satellite image. Overall, cloud type classification results were reasonable; some disturbing failures resulted as well as some success attained. More work is needed before an extensive, globally robust classifier can be developed and implemented in an operational sense into cloud analysis models such as the Air Force Real-time Nephanalysis (RTNEPH). GRA

N91-22651# Air Force Environmental Technical Applications Center, Scott AFB, IL.
RANGE REFERENCE ATMOSPHERE WAKE ISLAND
Nov. 1990 150 p
(AD-A231715; USAFETAC/PR-90/007) Avail: NTIS HC/MF A07 CSCL 04/2

This range reference atmosphere (RRA) is a statistical model (derived from upper-air observations) of the atmosphere from 0 to 30 km over Wake Island. It provides tabulations of monthly and annual means, standard deviations, and skewness coefficients for wind speed, barometric pressure, atmospheric temperature, atmospheric density, water vapor pressure, virtual temperature, and dew point temperature. It also gives mean and standard deviation for the zonal and meridional wind components and hydrostatic model atmosphere. Methodology is included, along with graphic displays of wind statistics that can be derived from the wind data. GRA

N91-22652# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (Germany, F.R.). Abt. Meteorologische Flugmessysteme.
INTERNATIONAL WORKSHOP ON THE AIRBORNE MEASUREMENT OF WIND, TURBULENCE AND POSITION: WORKSHOP REPORT
Hans P. Fimpel, Darrel Baumgardner (National Center for Atmospheric Research, Boulder, CO.), and Anne M. Jochum 23 Jun. 1990 85 p Workshop held in Oberpfaffenhofen, Fed. Republic of Germany, 26-28 Jul. 1989
(DLR-Mitt-90-13; ISSN-0176-7739; ETN-91-99037) Avail: NTIS HC/MF A05; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 25 Deutsche marks

The goal of this workshop was threefold: first to exchange information on measurement technology, calibration techniques, and analysis methods; second to discuss possible areas where standardization is beneficial, such as calibrations, data processing procedures, correction algorithms, and measurement uncertainty assessment and reporting; third to discuss possible future collaborations, in particular the development of new sensors, the assessment of uncertainty, and the exchanges of personnel betweeen facilities. The first half of the workshop consisted of oral presentations describing fundamental problems, new measurement systems, calibration techniques, and applications of the measurements. The second half of the workshop was devoted to working sessions that focused on research needs and measurement limitations. For individual titles, see N91-22653 through N91-22663.

N91-22653# National Center for Atmospheric Research, Boulder, CO.
AIR MOTION MEASUREMENTS: PAST AND FUTURE
Donald H. Lenschow *In* DLR, International Workshop on the Airborne Measurement of Wind, Turbulence and Position: Workshop Report 23 Jun. 1990 p 22-28 (For primary document see N91-22652 14-47)
Avail: NTIS HC/MF A05; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 25 Deutsche marks

The concept of using aircraft for air motion measurements is introduced. Their prime advantage is their mobility, however this mobility and their response to turbulence adds to the difficulty in obtaining accurate measurements. The latter is discussed and ways of overcoming these problems are presented. An historical survey of the use of airplanes as qualitative indicators of atmospheric motions is given and the measurement techniques, including vanes, pressure sensing probes and the inertial navigation system are presented. Based on the current status of aircraft instrumentation and the limits discussed, the needs for improved air motion sensing capabilities are summarized and a variety of possible technological solutions to these needs are given. ESA

N91-22654# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (Germany, F.R.). Abt. Meteorologische Flugmesssysteme.
AIR MOTION MEASUREMENT UNCERTAINTIES: THEIR IMPACT ON ATMOSPHERIC STUDIES
Darrel Baumgardner (National Center for Atmospheric Research, Boulder, CO.) *In its* International Workshop on the Airborne Measurement of Wind, Turbulence and Position: Workshop Report 23 Jun. 1990 p 29-35 (For primary document see N91-22652 14-47)
Avail: NTIS HC/MF A05; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 25 Deutsche marks

The effect of the uncertainties in the measurement of primary quantities (such as pressure or temperature) on the secondary quantities that are derived from them must be evaluated by propagating these uncertainties from the equations that relate the primary and secondary quantities. The process for derivation of errors in wind measurement is described and the possible magnitudes of the error are illustrated. Error propagation techniques provide a means of assessing the quality of measurements and guidance in data interpolation. The results showed that the accuracy in calculated winds would be improved by making only small improvements in the measurement of attack, sideslip, and heading angles. ESA

N91-22655# Flinders Univ., Bedford Park (Australia). Flinders Inst. for Atmospheric and Marine Science.
THE FIAMS RESEARCH AIRCRAFT OR SMALL IS BEAUTIFUL
Joerg M. Hacker *In* DLR, International Workshop on the Airborne Measurement of Wind, Turbulence and Position: Workshop Report 23 Jun. 1990 p 36-41 (For primary document see N91-22652 14-47)
Avail: NTIS HC/MF A05; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 25 Deutsche marks

The GROB G109B, a small research aircraft used in atmospheric boundary layer research projects, is presented. This aircraft was designed to measure basic meteorological parameters with a high

degree of accuracy. A list of the sensors and scientific systems fitted to the aircraft is given and the onboard data system is summarized. Since becoming operational in 1985 the aircraft was used in a wide variety of research projects all over Australia. As typical examples, some results from two observational studies are presented. These included investigation into the fine structure of a sea breeze front, and others into the vertical energy fluxes over a desert lake area. ESA

N91-22656# Centre d'Essais en Vol, Bretigny-sur-Orge (France).

TECHNICAL PRESENTATION OF THE MERLIN'S RADOME: CALIBRATION AND DATA PROCESSING

Michel Andre and Marie Pierre LePipec *In* DLR, International Workshop on the Airborne Measurement of Wind, Turbulence and Position: Workshop Report 23 Jun. 1990 p 42-46 (For primary document see N91-22652 14-47)

Avail: NTIS HC/MF A05; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 25 Deutsche marks

The status of the French meteorological research center's work on dynamic data is presented. The Merlin 4 is used for meteorological measurements. The different dynamic measurement points on the aircraft, radome, boom, Inertial Navigation System (INS), and Doppler radar, are illustrated. The radome data and inertial data are discussed. In the latter, angle data coding and pendular movement of the INS are given attention. It is concluded that the INS should be coupled with a reference. This is either the Doppler radar (though it is noisy), or the Ground Positioning System (GPS) which should be available within a few years. The Merlin's INS is already equipped with a GPS output, so this could be easily done. ESA

N91-22657# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (Germany, F.R.).

THE IMPROVEMENT OF THE INSTALLATION OF THE DLR RESEARCH AIRCRAFT FALCON: DESCRIPTION AND FIRST RESULTS

Robert Baumann, H. G. Christner, Hans P. Fimpel, and G. Wilke *In its* International Workshop on the Airborne Measurement of Wind, Turbulence and Position: Workshop Report 23 Jun. 1990 p 47-50 (For primary document see N91-22652 14-47)

Avail: NTIS HC/MF A05; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 25 Deutsche marks

The upgrading of the DLR research aircraft is discussed. The new modern Electronic Flight Information System (EFIS) is described along with its sources of information: the Inertial Reference System (IRS), the weather radar, and the Flight Management Computer (FMC). Results of comparisons between the new INS, the replaced INS, and the new FMC are given. The new data aquisition system is also described. It is concluded that the efficiency of flight management and the acccuracy of navigation data will be improved as a result of the modernization. ESA

N91-22658# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THE NASA-ER2 METEOROLOGICAL MEASUREMENT SYSTEM: INSTRUMENTAION, CALIBRATION AND INTERCOMPARISON RESULTS

K. Roland Chan, Stuart W. Bowen (San Jose State Univ., CA.), Stan G. Scott, and T. Paul Bui *In* DLR, International Workshop on the Airborne Measurement of Wind, Turbulence and Position: Workshop Report 23 Jun. 1990 p 51-55 (For primary document see N91-22652 14-47)

Avail: NTIS HC/MF A05; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 25 Deutsche marks

The NASA ER-2 aircraft is used as a platform for high altitude atmospheric missions. The Meteorological Measurement System (MMS) was designed specifically for atmospheric research to provide accurate, fast response, in situ measurements of pressure, temperature, and the three dimensional wind vector. The MMS consists of three subsystems: an air motion sensing system to measure the velocity of the air with respect to the aircraft, a high resolution Inertial Navigation System (INS) to measure the velocity of the aircraft with respect to the Earth, and a Data Acquisition System, to sample, process and record the measured quantities. Details of each of these systems are given. The location of the MMS instrumentation is illustrated. The calibration of the MMS is discussed and results on an intercomparison of MMS measurements, Vaisala radiosonde observation and radar tracking data are given. An illustration of the MMS measurement of vertical wind is given. ESA

N91-22659# Deutsche Airbus G.m.b.H., Bremen (Germany, F.R.).

FAST RESPONSE GUST MEASUREMENT DEVICE

Meinhard Schumuecker and Georg Lemonis *In* DLR, International Workshop on the Airborne Measurement of Wind, Turbulence and Position: Workshop Report 23 Jun. 1990 p 56-60 (For primary document see N91-22652 14-47)

Avail: NTIS HC/MF A05; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 25 Deutsche marks

A fast response gust measurement device for on line wind and turbulence measurement from the aircraft is described. The requirements of the gust measurement system are given and the five hole probe, the pressure transducers and the transfer function of the pneumatic lines are described. Flight test results are given. The gust sensor design bases on the connection of a Rosemount five hole probe to an isolated, temperature controlled pressure transducer unit by extremely short pneumatic lines. This arrangement results in an advantageous pneumatic frequency response of the system, with very high resonance frequencies and negligible response errors in the low frequency range. ESA

N91-22660# Aerodata Flugmesstechnik G.m.b.H., Brunswick (Germany, F.R.).

THE USE OF ARRAY PROCESSORS FOR REAL TIME, HIGH FREQUENCY TURBULENCE MEASUREMENTS

Manfred Haverland *In* DLR, International Workshop on the Airborne Measurement of Wind, Turbulence and Position: Workshop Report 23 Jun. 1990 p 61-65 (For primary document see N91-22652 14-47)

Avail: NTIS HC/MF A05; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 25 Deutsche marks

For the real time computation of the components of wind velocity there is a need for fast arithmetic coprocessors. A solution to do this task within a few milliseconds is presented. It involves the use of an array processor. The measurement of the wind and the data system involved are described in detail. ESA

N91-22661# Eidgenoessische Technische Hochschule, Zurich (Switzerland). Atmospheric Physics.

SUMMARY OF AIRCRAFT MEASURING ACTIVITIES AT LAPETH

Bruno Neininger and Hans Richner *In* DLR, International Workshop on the Airborne Measurement of Wind, Turbulence and Position: Workshop Report 23 Jun. 1990 p 66-67 (For primary document see N91-22652 14-47)

Avail: NTIS HC/MF A05; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 25 Deutsche marks

Two completely different types and sizes of aircraft used in atmospheric research, instrumented motorgliders, and wide bodied airliners with Aircraft Integrated Monitoring Systems (AIMS) are presented. The instrumentation for dedicated research flights, on specially equipped aircraft is listed and details of the post flight software and the measuring platforms used are given. The missions which have been flown and the data evaluated are given. Details of the AIMS equipped aircraft and in airline services are given. The outlook for a new dedicated measuring platform is presented. ESA

N91-22662# Direction de la Meteorologie Nationale, Magny les Hameaux (France).
NUMERICAL MODELISATION OF AIRFLOW ON THE NOSE OF THE FRENCH RESEARCH AIRCRAFT MERLIN-4 FOR MEASURING AIR MOTION
Philippe L. Nacass *In* DLR, International Workshop on the Airborne Measurement of Wind, Turbulence and Position: Workshop Report 23 Jun. 1990 p 68-73 (For primary document see N91-22652 14-47)
Avail: NTIS HC/MF A05; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 25 Deutsche marks

Details of the Fairchild Merlin-4 used for atmospheric research including its main performance and limitations are given. Its instruments, used for state parameters and air motion measurements, the principal sensors and their position on the aircraft, are described. With data recorded during whole flights, the radome is calibrated and its performance evaluated. Theory of pressure measurement and the Merlin flight envelope are discussed. It is concluded that three dimensional flow distortions on the nose of the Merlin-4 must be better known to understand the potential effect on the pressure radome, on the ring of sensors around it and about the four particle measuring system pods under the fuselage. A code of numerical flow pattern calculation, around three dimensional bodies, is developed. First results are the pressure distributions on the fuselage of the Merlin-4 which are illustrated. ESA

N91-22663# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (Germany, F.R.). Abt. Meteorologische Flugmesssysteme.
TURBULENCE PROFILING IN THE ATMOSPHERIC BOUNDARY LAYER USING THREE POWERED GLIDERS
Anne M. Joachum *In its* International Workshop on the Airborne Measurement of Wind, Turbulence and Position: Workshop Report 23 Jun. 1990 p 74-77 (For primary document see N91-22652 14-47)
Avail: NTIS HC/MF A05; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 25 Deutsche marks

Three instrumented ASK 16 powered gliders are being operated as meteorological research aircraft. A low flight speed enabling the resolution of very small scales and a high degree of flexibility makes them the ideal research platform even for complex terrain studies. Due to their limited altitude range and payload they are primarily used in the atmospheric boundary layer. The investigation of the atmospheric boundary layer requires high spacetime resolution, and this is achieved by the utilization of three identically equipped aircraft. The main objectives in developing such a system, and thus its basic advantages are summarized. The main characteristics of the basic measurement system are presented, and the quality of the measurements are discussed. ESA

N91-22664 Royal Netherlands Meteorological Inst., De Bilt. Afd. Projectonwikkeling, Evaluatie en Ondersteuning.
VERIFICATION OF SHORT TERM (TEST PERIOD) QUANTITATIVE PRECIPITATION FORECASTS FOR FIVE REGIONS [VERIFICATIE KWANTITATIEVE NEERSLAGVERWACHTING KORTE TERMIJN (PROEFPERIODE) VOOR 5 REGIO'S]
D. Messerschmidt 1990 32 p In DUTCH; ENGLISH summary (KNMI-TR-126; ISSN-0169-1708; ETN-91-99102) Copyright
Avail: Royal Netherlands Meteorological Inst., P.O. Box 201, 3730 AE De Bilt, Wilhelminalaan 10, Netherlands

Quantitative precipitation forecasts were verified with a view to the increasing demand for quantitative regional precipitation forecasts by professional users. The amount of material was so small that a watertight conclusion can hardly be given, and that a comparison with climate and persistency was omitted. It is only in relation to the amount of precipitation that the meteorologist is better able to give a reliable forecast for his own region, but this is certainly not the case for the other aspects of the verification. The forecaster is probably able to give a reasonable quantitative short term precipitation forecasts. However, the meteorologist tends to overestimate the probability, particularly concerning the southern regions, the very short term forecasts and the forecasts of 30, 50, 60, and 100 percent. ESA

N91-22665# National Defence Research Establishment, Umea (Sweden).
MEASUREMENTS OF AIR QUALITY AND METEOROLOGICAL CONDITIONS IN SEVEN COMMUNITIES IN NORTHERN SWEDEN
Lennart Thaning, Per-Erik Johansson, Edvard Karlsson, Ann-Charlotte Nilsson, and Bertil Forsberg (Umea Univ., Sweden) Feb. 1991 58 p In SWEDISH; ENGLISH summary
(FOA-C-40281-4.5; ISSN-347-2124; ETN-91-99108) Avail: NTIS HC A04/MF A01; National Defence Research Establishment, S-901 82 Umeaa, Sweden, HC 100 Swedish crowns

Measurements of air pollution and meteorological conditions were made during January to April 1990 in seven communities in the inland of northern Sweden. One of the communities, Jokkmokk, was chosen as the main measurement place. The concentration of particulate carbon was higher than in other places in Sweden. High correlation was found between concentration of pollutants and air temperature, wind velocity and atmospheric stability. This correlation was also higher than in other places in Sweden. ESA

N91-22666# Beleidscommissie Remote Sensing, Delft (Netherlands).
ON THE USE OF AN ADVANCED IMAGE PROCESSING SYSTEM FOR THE AUTOMATIC DERIVATION OF QUANTITATIVE INFORMATION FROM METEOSAT IMAGES
S. H. Miller (Royal Netherlands Meteorological Inst., De Bilt.) Nov. 1990 11 p
(BCRS Proj. TO-1.19)
(BCRS-90-16; ETN-91-99156) Avail: NTIS HC/MF A03

The potential use of an advanced image processing system (context vision) for the retrieval of physical information from satellite (Meteosat) images is evaluated. Interest is focused on methods which make full use of the spatial information, can be applied fully automatically, are in principle independent of the use of climatological information so that the derived data can also be used for climate studies. Publications related to the retrieval of physical information from satellite images by the use of complex spatial information are reviewed, and a short overview of the properties of the Context Vision system is given. ESA

N91-22667# Beleidscommissie Remote Sensing, Delft (Netherlands).
COMPARISON OF TOSCANE-2 DATA AND DONELAN-PIERSON MODEL
G. H. F. M. Hesselmans and C. J. Calkoen (Delft Hydraulics Lab., Netherlands) Nov. 1990 52 p
(BCRS Proj. AO-1.4)
(BCRS-90-18; ETN-91-99157) Avail: NTIS HC/MF A04

Part of the ERS-1 satellite is a C band VV (Vertical Vertical) polarization wind scatterometer. An algorithm was developed to derive wind speed from the radar backscatter signal. To obtain a data base for future instrument studies, multifrequency airborne scatterometer measurements were made with the DUTSCAT scatterometer during the TOSCANE 2 campaign. The radar measurements are related to wind speed and compared with the theoretical two scale DP-model. The model is explained and the validity of the implementation is discussed. The experimental and calculated results are described and related to wind speed. The experimental and numerical data are compared. A discussion and a conclusion are included. ESA

N91-22668# Bristol Univ. (England). Dept. of Aerospace Engineering.
DESIGN OF BUILDINGS TO CAUSE HIGH WIND FOR LOCAL LEISURE ACTIVITY B.S. Thesis
Kevin Griffiths Jun. 1990 53 p
(BU-503; ETN-91-99196) Avail: NTIS HC/MF A04

Much work has been performed in order to reduce wind from

areas of inland water. This project was concerned with the improvement of wind conditions, but instead of reducing the wind, work was concerned with improving conditions for sailors, within cities. The question has not been addressed previously. The concept of using tall buildings to modify the flow was investigated experimentally. Tests were performed in an industrial engineering wind tunnel. A boundary layer simulation was used to model a datum site. Experiments analyzed the improvements created by varying the size and positions upstream. Improvements of up to 100 percent were recorded during the project. The various schemes that were examined were discussed and recommendations were made for future studies. ESA

N91-22669*# Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
OPTIMAL COMBINING OF GROUND-BASED SENSORS FOR THE PURPOSE OF VALIDATING SATELLITE-BASED RAINFALL ESTIMATES Final Report
Witold F. Krajewski, David T. Rexroth, and Kiriakie Kiriaki May 1991 143 p
(Grant NAG5-1126)
(NASA-CR-188185; NAS 1.26:188185) Avail: NTIS HC/MF A07 CSCL 04B

Two problems related to radar rainfall estimation are described. The first part is a description of a preliminary data analysis for the purpose of statistical estimation of rainfall from multiple (radar and raingage) sensors. Raingage, radar, and joint radar-raingage estimation is described, and some results are given. Statistical parameters of rainfall spatial dependence are calculated and discussed in the context of optimal estimation. Quality control of radar data is also described. The second part describes radar scattering by ellipsoidal raindrops. An analytical solution is derived for the Rayleigh scattering regime. Single and volume scattering are presented. Comparison calculations with the known results for spheres and oblate spheroids are shown. Author

N91-22670# National Oceanic and Atmospheric Administration, Boulder, CO. Wave Propagation Lab.
REMOTE SENSOR OBSERVATIONS DURING WISP90: THE USE OF MICROWAVE RADIOMETERS, RASS, AND CEILOMETERS FOR DETECTION OF AIRCRAFT ICING CONDITIONS
B. B. Stankov, E. R. Westwater, J. B. Snider, and R. L. Weber Nov. 1990 83 p
(PB91-131839; NOAA-TM-ERL-WPL-187) Avail: NTIS HC/MF A05 CSCL 04B

During Feb. and Mar. 1990, the National Center for Atmospheric Research, the National Oceanic and Atmospheric Administration (NOAA) Wave Propagation Laboratory, and the NOAA Forecast Systems Laboratory conducted the Winter Icing and Storms Project (WISP). One of the principal objectives was to determine the utility of unattended microwave radiometers in detecting atmospheric liquid water and providing input to forecasts of aircraft icing. Arrays of microwave radiometers, infrared radiometers, lidar ceilometers, and radio-acoustic sounding systems were used to determine spatial and temporal distribution of supercooled liquid water. Results are presented from four representative cases to demonstrate that the integrated system, which comprises a microwave water substance radiometer, a radio-acoustic sounding system, and a ceilometer, can identify supercooled liquid water. Occasional outages because of environmental effects on the radiometer antenna were encountered, and quality control procedures were employed to detect erroneous data. GRA

N91-22671# Los Alamos National Lab., NM.
ON THE MEASUREMENT OF WIND SPEEDS IN TORNADOES WITH A PORTABLE CW/FM-CW DOPPLER RADAR
H. B. Bluestein (Oklahoma Univ., Norman.) and W. P. Unruh 1991 15 p Presented at the 3rd Tornado Symposium, Norman, 2-5 Apr. 1991
(Contract W-7405-eng-36)
(DE91-008589; LA-UR-91-556; CONF-9104193-1) Avail: NTIS HC/MF A03

Both the formation mechanism and structure of tornadoes are not yet well understood. The Doppler radar is probably the best remote-sensing instrument at present for determining the wind field in tornadoes. Although much has been learned about the non-supercell tornado from relatively close range using Doppler radars at fixed sites, close-range measurements in supercell tornadoes are relatively few. Doppler radar can increase significantly the number of high-resolution, sub-cloud base measurements of both the tornado vortex and its parent vortex in supercells, with simultaneous visual documentation. The design details and operation of the CW/FM-CW Doppler radar developed at the Los Alamos National Laboratory and used by storm-intercept teams at the Univ. of Oklahoma are described elsewhere. The radar transmits 1 W at 3 cm, and can be switched back and forth between CW and FM-CW modes. In the FM-CW mode the sweep repetition frequency is 15.575 kHz and the sweep width 1.9 MHz; the corresponding maximum unambiguous range and velocity, and range resolution are 5 km, + or - 115 m/s, and 78 m respectively. The bistatic antennas, which have half-power beamwidths of 5 degrees, are easily pointed wit the aid of a boresighted VCR. FM-CW Data are recorded on the VCR, while voice documentation is recorded on the audio tape; video is recorded on another VCR. The radar and antennas are easily mounted on a tripod, and can be set up by three people in a minute or two. The purpose of this paper is to describe the signal processing techniques used to determine the Doppler spectrum in the FM-CW mode and a method of its interpretation in real time, and to present data gathered in a tornadic storm in 1990. DOE

48 OCEANOGRAPHY

Includes biological, dynamic, and physical oceanography; and marine resources.

For related information see also *43 Earth Resources and Remote Sensing.*

N91-22672# Naval Postgraduate School, Monterey, CA.
AN ASSESSMENT OF DATA REQUIREMENTS FOR QUASIGEOSTROPHIC NOWCASTS AND HINDCASTS OF A MESOSCALE EDDY FIELD IN THE CALIFORNIA CURRENT SYSTEM WITH APPLICATION TO FALL TRANSITION M.S. Thesis
John E. Johnson 29 Mar. 1990 369 p
(Contract N00014-6WR-24027; NR Proj. RR0-3103)
(AD-A231394) Avail: NTIS HC/MF A16 CSCL 08/3

An extensive Ocean Prediction Through Observation, Modeling, and Analysis (OPTOMA) domain, off Northern and Central California, was surveyed in November 1986, during OPTOMA 23. Surface dynamic height (SDH), sea surface temperature (SST), and other fields were mapped with a Gandin objective analysis (OA) model; stream function nowcasts and hindcasts of the mesoscale oceanic field were generated by a quasigeostrophic (QG) model, initialized and updated with OA fields of dynamic topography. The westward propagation, at 5 to 10 km/day, of an anticyclone was the predominant mesoscale event; cyclonic features were quasi-stationary. The Generalized Digital Environmental Model had accurate averages and ranges of values, but was not representative of the mesoscale field. Because the mesoscale field did not change much over the ten-day period, persistence fields scored well. QG hindcasts were most sensitive to data density, The transition in the autumn of 1986 in the California Current System was a chronic event; winds favorable for upwelling fluctuated and diminished in late October, but occurred during short periods through December. A balance of alongshore pressure gradient and wind stress at Monterey shifted from a maximum southward in late November to maximum northward two weeks later. The northward nearshore flow was observed in satellite imagery, SDH and SSH OA fields, and in QG hindcasts. GRA

N91-22673# Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
DATA EMPLOYED IN THE DEVELOPMENT OF A THREE-DIMENSIONAL, TIME-VARYING NUMERICAL HYDRODYNAMIC MODEL OF CHESAPEAKE BAY Final Report
Alan F. Blumberg, Billy H. Johnson, Ronald H. Heath, Bernard B. Hsieh, and Virginia R. Pankow Jan. 1991 222 p
(AD-A231654; WES/TR/HL-91-1) Avail: NTIS HC/MF A10 CSCL 08/3

A successful calibration/verification of a numerical hydrodynamic model applied to an estuarine/coastal area requires sets of self-consistent data. These data sets must contain: (1) freshwater inflows on tributaries; (2) tides at ocean entrances as well as at various interior stations; (3) meteorological data at one or more stations, from which the surface wind stress and heat flux can be determined; (4) and currents, temperature, and salinity at several locations throughout the modeled area. The bathymetry must also be presented on the numerical grid. This report presents data sets employed in the development of a three-dimensional hydrodynamic model of the Chesapeake Bay. Since the Bay is so large, there is a lack of synoptic data throughout the Bay and its tributaries. Three relatively extensive synoptic field data sets were identified for use in this study. These data sets were collected during June - July 1980, April 1983, and September 1983. For the preliminary calibration of the hydrodynamic model, data from the physical model of Chesapeake Bay located on Kent Island, were identified. Data from each of the sets are presented in a combination of graphical and tabular forms. GRA

N91-22674# Hawaii Univ., Honolulu. Dept. of Oceanography.
DYNAMICS OF SMALL-SCALE OCEANIC MOTIONS
Peter Mueller 1990 4 p
(Contract N00014-90-J-1419)
(AD-A231718) Avail: NTIS HC/MF A01 CSCL 08/3

The research goals were: (1) Description and modeling of the kinematical structure and dynamical processes of oceanic motions that have horizontal scales from a few meters to a few kilometers; and (2) understanding the role that these small-scale motions play in the redistribution and mixing of momentum, potential vorticity, heat, and salt. The objective were: to arrive at a complete kinematical description of small-scale motions in terms of gravity and vortical (i.e., potential vorticity carrying) motions; to assess the feasibility of monitoring internal wave parameters from routinely taken measurements with ship mounted Acoustic Doppler Current Profilers; and to determine and parameterize the effect of internal gravity waves absorbed in critical layers. The approach was by theoretical and data analyses. GRA

N91-22675# Hawaii Univ., Honolulu. Dept. of Oceanography.
INTERNAL GRAVITY WAVES AT ABRUPT TOPOGRAPHY. ARI: FLOW OVER ABRUPT TOPOGRAPHY
Peter Miller 1990 4 p
(Contract N00014-89-J-1315)
(AD-A231756) Avail: NTIS HC/MF A01 CSCL 08/3

Research goals of this study include identification and modeling of the dynamical processes that determine the oceanic internal gravity wave spectrum, its evolution, and its variability, and understanding the role that internal waves play in the redistribution and mixing of momentum, potential vorticity, heat and salt. Objectives were identification and modeling of the effects that irregular ocean bottom topography exerts on internal gravity waves; determining the significance of these effects by comparison with other known processes; testing the idea that reflection and scattering of internal gravity waves at bottom topography and the subsequent (nonlinear) adjustments enhance wave breaking and mixing near topography. Tasks completed were derivation of the scattering integral in the limit that the height of the topography is smaller than the internal wave vertical wavelength, and the slope of the topography is smaller than the slope of the internal wave characteristic. GRA

N91-22676# California Univ., Santa Barbara. Marine Science Inst.
QUANTITATIVE ASSESSMENT OF THE SLOPE RESOLUTION OF SEAFLOOR MAPPING SYSTEMS Annual Report
Ken C. MacDonald, S. P. Miller, and C. P. DeMoustier 30 Jan. 1991 6 p
(Contract N00014-90-J-1737)
(AD-A231776) Avail: NTIS HC/MF A02 CSCL 08/3

Through careful analyses of overlapping seafloor maps and data sets that were collected by systems with different resolution, and different processing schemes, we would like to know which scales of roughness are truely resolved, and which scales are obscured by the sonar system or by data processing effects. To this end, we combine a theoretical analysis of the slope resolution of various sonar system with validation from actual data drawn from an extensive data base of swath imagery from sidelooking sonar as well as high-resolution swath bathymetry which have been collected on the East Pacific Rise and on the Mid-Atlantic Ridge. The theoretical study suggests that it is the echo detection process which dominates the error budget that ultimately limits the bottom slope resolution. GRA

N91-22677# Woods Hole Oceanographic Inst., MA.
ALTIMETER PROCESSING TOOLS FOR ANALYZING MESOSCALE OCEAN FEATURES
Michael J. Caruso, Ziv Sirkes, Pierre J. Flament, and M. K. Baker Sep. 1990 210 p
(Contract N00014-86-K-0751)
(AD-A231904; WHOI-90-45) Avail: NTIS HC/MF A10 CSCL 12/5

The U.S. Navy altimeter satellite GEOSAT was designed to provide a highly improved marine geoid. In October 1986, it was moved into a 17-day exact repeat orbit. The new orbital parameters corresponded to the 1978 Seasat mission and was corrected periodically to provide a groundtrack repeatability to within 1 km. The primary purpose of this project is to perform a 'repeat' or 'collinear' track analysis. This analysis requires sorting the data into collinear tracks, correcting the sea surface heights for various measurement errors and regridding the along-track data to a common grid. To use this data, a software package was developed at the WHOI and the Univ., of Hawaii to facilitate the extraction of useful information from the NODC distributed GEOSAT data tapes. This software package was written with portability and modularity in mind. It should be possible to use this package with little or no modifications on data from future altimeters. The code was written in C and tested on Sun workstations and is oriented toward UNIX operating systems. However, since standard code was used, the programs should port easily to other computer systems. The modularity of the code should enable users to create addition programs. Additional programs designed to handle collocated water vapor corrections are also included for comparison. GRA

N91-22678# Scripps Institution of Oceanography, La Jolla, CA. Marine Physical Lab.
SEAMARC 2 INVESTIGATION OF THE NORWEGIAN-GREENLAND SEA Final Report, 15 May 1989 - 30 Sep. 1990
Christian DeMoustier Jan. 1991 8 p
(Contract N00014-89-J-1963)
(AD-A231917; MPL-U-27/90) Avail: NTIS HC/MF A02 CSCL 08/3

More than 80,000 sq km of SeaMARC II imagery was obtained in the northern Norwegian-Greenland Sea during October and November, 1989. Regions insonified included the Bjorneya Fan, a transect at 73 deg N from the continental margin to the Mohns Ridge, an along axis section of the entire Knipovich Ridge (the slowest spreading center in the world), the Molly Deep, the Spitsbergen Transform Fault, a portion of the Yermak Plateau and the 1,000 m isobath from Svalbard south to the Norwegian margin. The internal structure of the Knipovich Ridge is highly en echelon and oriented obliquely to the regional trend of the ridge. Unusual sedimentary features, perhaps related to ancient glacial

activity, scour the margin of the Barents Sea at its intersection with the Norwegian-Greenland Sea. Pockmarks dot the sediment surface off the northwestern margin of Svalbard. These may be attributed to bubbles escaping from subjacent natural gas fields. Further north on the Yermak Plateau, iceberg plough marks criss-cross the terrain. In addition to routine surveying, we carried out acoustic experiments in three locations attempting to analyze the SeaMARC 2 system related effects on the acoustic measurements and to test different processing algorithms to try to improve the bathymetric function. GRA

N91-22679# Dartmouth Coll., Hanover, NH. School of Engineering.
MESOSCALE EDDIES AND FRONTS Final Technical Report, 1 Jan. 1989 - 31 Jan. 1991
Benoit Cushman-Roisin 31 Jan. 1991 2 p
(Contract N00014-89-J-1574)
(AD-A231933) Avail: NTIS HC/MF A01 CSCL 08/3

The oceanic geostrophic turbulence and other mesoscale processes related to eddies and fronts were studied. A numerical study was made of internal tides, and an international colloquium on oceanic vortices was organized. GRA

N91-22680# Beleidscommissie Remote Sensing, Delft (Netherlands).
DASWAM: A PROGRAM FOR DATA-ASSIMILATION IN A 3RD GENERATION WAVE MODEL
P. Groenewoud (Delft Hydraulics Lab., Netherlands) Nov. 1990 47 p
(BCRS Proj. OP-1.29)
(BCRS-90-15; ETN-91-99155) Avail: NTIS HC/MF A03

DASWAN is a computer algorithm for data assimilation in a third generation wave prediction model. DASWAN corrects simultaneously the computed sea states and the wind fields driving the wave model. The wind fields are adjusted iteratively, to minimize the difference between wave model output and observations. An approximate model replaces the (expensive) third generation wave model during the minimization. The modularity of the program facilitates the maintenance of the procedures that are subject to further improvement or even replacement (e.g., the wave model). As a framework, DASWAN provides quite extensive possibilities for input and output of data. Certain aspects of an operational situation can be simulated by using the internal restart option. Site dependent tasks such as storage and retrieval of data are part of a separate pre and postprocessing program called PRESAT. The composition of the (external) system documentation and the user aspects of the DASWAN program are presented. ESA

N91-23070*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
INSTRUMENTATION FOR OPTICAL OCEAN REMOTE SENSING
W. E. Esaias *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 400-412 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 08C

51 LIFE SCIENCES (GENERAL)

N91-22681# Weizmann Inst. of Science, Rehovoth (Israel).
EIGHTH INTERNATIONAL SYMPOSIUM ON AFFINITY CHROMATOGRAPHY AND BIOLOGICAL RECOGNITION: PROGRAM AND ABSTRACTS Abstracts Only
3 Nov. 1989 126 p Symposium held in Jerusalem, Israel, 29 Oct. - 3 Nov. 1989; sponsored by Israel Academy of Sciences and Humanities, Maurice and Gabriela Goldschleger Conference Foundation at the Weizmann Inst. of Science, Israel Ministry of Science and Development,
(ITN-91-85064) Copyright Avail: NTIS HC/MF A07

Papers presented at the Symposium covered new developments in affinity-based separation, DNA-protein interactions, general concepts and applications of receptors, applications of protein-ligand interactions, biosensors and immunoassay, immunoaffinity separations, selected applications, tailor-made enzymes and receptors, and novel matrices and affinity approaches. For individual titles, see N91-22682 through N91-22696.

N91-22682# Tel-Aviv Univ. (Israel). Dept. of Biotechnology.
ACHIEVEMENTS, DIFFICULTIES AND PREDICTED DEVELOPMENTS IN IMMUNOAFFINITY CHROMATOGRAPHY Abstract Only
Ephraim Katchalski-Katzir *In* Weizmann Inst. of Science, 8th International Symposium on Affinity Chromatography and Biological Recognition: Program and Abstracts 3 Nov. 1989 2 p (For primary document see N91-22681 14-51)
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The recent wide use of immunoaffinity chromatography arises from the availability of an increasing variety of monoclonal antibodies (MAb), which can be covalently bound onto chosen water-insoluble carriers. However, MAbs represent labile proteins, are relatively expensive and are produced by hybridoma cells which might lead to the appearance of trace amounts of biologically hazardous materials in conjunction with the immunoaffinity purified antigen. Elution of absorbed proteins from the MAb-carrier conjugates should be performed under the mildest possible conditions, to avoid irreversible denaturation of both the adsorbed protein and the bound antibody. A detailed x-ray three-dimensional analysis of the complexes between lysozyme and the Fab fragments of corresponding MAbs has led to the elucidation of the interaction between the enzyme-antigen and its corresponding MAbs on an atomic scale. Some techniques for the covalent binding of antibodies onto their corresponding carriers lead to partial inactivation of the MAbs used, or to antibody leakage from the carrier-MAb conjugate. A detailed investigation has been made of the covalent binding techniques used for antigen purification, with particular emphasis on the direct binding of MAbs to epoxy groups of a carrier, and to the directed binding of chemically or enzymatically oxidized MAbs onto hydrazide containing carriers. The possible immobilization of MAbs via anti-Fc immunoglobulins has also been considered. In some cases, a marked increase in immobilized MAb activity was recorded when the available amino groups of the antibody were reversibly blocked with dimethylmaleic anhydride before coupling with a chemically reactive carrier. MAbs were found to differ markedly in their response to the various reagents and procedures used. An assay has been developed to monitor the amount of non-specifically adsorbed proteins, and procedures have been developed to reduce non-specific adsorption, which could lead to severe contamination of the protein product. Polyethylene glycol, of average m.w. 400 or 1,500, was found particularly useful for this purpose. ISA

N91-22683# Tel-Aviv Univ. (Israel). Lab. of Neurobiochemistry.
AFFINITY CHROMATOGRAPHY PURIFICATION OF THE NMDA/PHENCYCLIDINE RECEPTOR COMPLEX Abstract Only
A. F. Ikin, Y. Kloog, and Mordechai Sokolovsky *In* Weizmann Inst. of Science, 8th International Symposium on Affinity Chromatography and Biological Recognition: Program and Abstracts 3 Nov. 1989 1 p (For primary document see N91-22681 14-51)
Copyright Avail: NTIS HC/MF A07

The N-methyl-D-aspartate (NMDA) / phencyclidine (PCP) receptor from rat forebrain was solubilized with sodium cholated and purified to apparent homogeneity by a single step of affinity chromatography on amino-PCP-agarose. By means of this single purification step (with a relatively short purification time: 12-15 hrs) about 3700-fold purification was achieved. Polyacrylamide gel electrophoresis in the presence of sodium dodecyl sulfate and dithiothreitol revealed four major bands of Mr 67,000, 57,000, 46,000 and 33,000. (H3)-azido PCP was irreversibly incorporated into each of these bands after UV-irradiation. The dissociation constant (K sub D) of (1-(1-thienyl)cyclohexyl) piperidine((H3)TCP) binding to the purified NMDA/PCP receptor was 120 nM. The maximum specific binding (B sub max) for (H3)TCP binding was

3.3 nmol/mg protein. The binding and pharmacological features of the purified receptor are similar to those observed in membranes and in soluble extracts. Purification did not significantly alter the binding affinities of the noncompetitive channel blockers, and the stereoselectivity of their binding site was unimpaired. The binding of (H3)TCP to the purified complex exhibited a sensitivity to NMDA-receptor ligands similar to that seen in membranes. The marked effect of glycine on glutamate-induced or NMDA-induced (H3)TCP binding and the effect of PCP-receptor complex was functionally purified, since the interaction between the different ligand sites (glutamate, glycine) and the channel was maintained.
Author (ISA)

N91-22684# Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Virology.
SOLUBLE CYTOKINE-RECEPTORS ARE PRESENT IN NORMAL HUMAN URINE Abstract Only
Daniela Novick, Hartmut Engelmann, David Wallach (InterPharm Labs., Nes-Ziona, Israel), and Menachem Rubinstein *In its* 8th International Symposium on Affinity Chromatography and Biological Recognition: Program and Abstracts 3 Nov. 1989 1 p (For primary document see N91-22681 14-51)
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Analysis of urine from normal donors was performed in order to address the question whether release of soluble cytokine receptors into body fluids is a general phenomenon. Affinity chromatography of crude human urinary proteins on either immobilized human rIL-6, human rIFN-gamma or monoclonal anti IFN-gamma receptor antibody yielded the respective two soluble receptors in significant quantities. A single sequence of 30 a.a. residues was obtained by N-terminal microsequencing of the protein peak purified in two steps (affinity chromatography on IL-6 column and RP-HPLC). This sequence was identical to the predicted N-terminal sequence of IL-6 receptor as previously reported by Yamasaki et al. (1988). Analysis of the eluted proteins from both IFN-gamma and anti IFN-gamma receptor columns by inhibition of sRIA, ELISA, SDS-PAGE, and Western blotting proved the existence of soluble IFN-gamma receptor in normal urine. This finding together with the already known presence of urinary TNF binding proteins and a soluble IL-2 receptor both in plasma and in urine, indicates that release of soluble cytokine receptors into body fluids is a general phenomenon which occurs under normal physiological conditions. Author (ISA)

N91-22685# Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Biophysics.
AVIDIN-BIOTIN TECHNOLOGY Abstract Only
Edward A. Bayer and Meir Wilchek *In its* 8th International Symposium on Affinity Chromatography and Biological Recognition: Program and Abstracts 3 Nov. 1989 1 p (For primary document see N91-22681 14-51)
Copyright Avail: NTIS HC/MF A07

The application of avidin-biotin technology, originally designed to facilitate and improve purification and localization procedures for biologically active macromolecules, has led to major advances in medical diagnostics. Among other new applications are affinity targeting, crosslinking and immobilization studies, cell cytometry, blotting technology, drug delivery, bioaffinity sensors, fusogenic sensors and hybridoma technology. Biotin, coupled to low- or high-molecular weight molecules, can still be recognized by avidin, so that mediation through the avidin-biotin complex often leads to a dramatic enhancement in signal and/or sensitivity levels. In recent years, there has been a tendency to replace egg-white avidin with the bacterial cognate, streptavidin, which is a nonglycosylated, neutral protein with a similarly high affinity constant for binding biotin, and which is free of the egg-white protein's oligosaccharide moiety and basicity. A number of new biotin-containing reagents and additional avidin- and streptavidin-conjugated probes have been designed. Modification of some of the disadvantageous properties of the egg-white glycoprotein is being attempted, since it is much less expensive than the bacterial protein. Determination of the structural and functional requirements for the high-affinity avidin-biotin interaction is being attempted, with the aim of improving its application and better understanding other lower-order affinity interactions. ISA

N91-22686# Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Hormone Research.
NEW DEVELOPMENTS AND APPLICATIONS OF IMMUNOASSAY TECHNOLOGY Abstract Only
Fortune Kohen and G. Barnard (City Univ., London, England) *In its* 8th International Symposium on Affinity Chromatography and Biological Recognition: Program and Abstracts 3 Nov. 1989 1 p Sponsored by Georgetown Univ. Medical School, Washington, DC (For primary document see N91-22681 14-51)
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In addition to radio labelling, four types of labels are used in immunoassay technology: particles, enzymes, fluorophores and chemiluminophores. Of these labels, the lanthanide chelates, e.g., europium, can yield higher specific activities than commonly used radioisotopes, and have different fluorescence emission wavelengths, which can be discriminated by appropriate filters. In addition, the fluorescence half-lives of lanthanide chelates are up to six orders of magnitude longer than those of conventional fluorophores; use of the principles of time-resolution enables the fluorescence of these chelates to be distinguished from the inherent fluorescence of biological materials, which has a very short half-life, on the order of nanoseconds. Consequently, the use of lanthanide chelates as labels in immunoassay procedures permitted the in-house development of sensitive, competitive type immunoassays for the direct measurement of haptens, two-site biotin-avidin interaction-based immunoassays for macromolecules and non-separation immunoassays for urinary steroid metabolites, for the delineation of the fertile period in women and for use in in-vitro fertilization programs. The principle of two-site immunoassays is being applied to mapping the antigenic epitopes of peptide hormones. The data obtained from two-site binding assays were used to generate computer-simulated three-dimensional representations of the antigenic sites in human growth hormone and variants that are recognized by the various monoclonal antibodies. This technique will be applied to proteins whose x ray structures are known, in order to compare electron density of proteins, as represented by x ray crystallography, with the computer-generated three-dimensional representation of the antigenic surface of macromolecules. ISA

N91-22687# Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Biophysics.
HIGH PERFORMANCE THIOPHILIC ADSORPTION FOR ANTIBODY PURIFICATION Abstract Only
Bernhard Nopper, Fortune Kohen, and Meir Wilchek *In its* 8th International Symposium on Affinity Chromatography and Biological Recognition: Program and Abstracts 3 Nov. 1989 1 p (For primary document see N91-22681 14-51)
Copyright Avail: NTIS HC/MF A07

Thiophilic adsorption chromatography, as developed by Porath and colleagues (1985), was modified and transformed to the high performance liquid chromatography (HPLC) mode on silica beads. The modification involves the introduction of an additional thioether group near the silica site of the ligand. This was accomplished by opening the epoxy ring on epoxy silica with sodium hydrosulfide. This reaction enabled the introduction of a thiol group on the silica. The thiol silica was used to react with divinyl sulfone and mercaptoethanol to yield the thiophilic adsorbent which was named 3S-silica. The 3S-adsorbent is of high capacity and is suitable for the fast and single-step purification of all subclasses of monoclonal and polyclonal antibodies. Other epoxy- or thiol-containing polymers were converted to 3S-adsorbents and were found to be very efficient in antibody purification. Due to their broad specificity, the 3S-thophilic adsorbents are an inexpensive substitute for protein A and protein G columns for purification on antibodies.
Author (ISA)

N91-22688# Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Neurobiology.

AFFINITY-REPULSION CHROMATOGRAPHY Abstract Only

Vivian I. Teichberg *In its* 8th International Symposium on Affinity Chromatography and Biological Recognition: Program and Abstracts 3 Nov. 1989 1 p (For primary document see N91-22681 14-51)

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In protein purification by affinity chromatography, the desired protein binds to one of its specific ligands immobilized on an insoluble and neutral matrix while other proteins in the mixture do not. The retained protein can be removed from the matrix by addition of its free ligand, at concentrations allowing a displacement from the immobilized ligand, and recovered in solution as a complex with its free ligand, from which it can be dissociated by dialysis or molecular sieving. For proteins associating to the immobilized ligand with an association constant greater than 10(exp -9) M, addition of the free ligand is insufficient, and more drastic elution conditions need to be applied. Affinity-repulsion chromatography was devised to circumvent these difficulties; it enables proteins to be eluted from affinity columns by addition of deionized water. The method is based on the fact that both the affinity chromatography matrix and the proteins which interact with it possess electrostatic charges which can attract or repel one another, according to their sign and respective distances. The effect of such electrostatic interactions is small in solutions containing high salt concentrations, but can become considerable in deionized water. Thus, if a protein and the affinity matrix carry the same overall net electrostatic charge, the protein will be eluted by deionized water whenever the strength of the electrostatic repulsion between the protein and the matrix exceeds the attractive forces between the protein and the immobilized ligand. Such situations can be achieved by appropriate chemical modifications of the affinity matrix, so as to increase the charge density and adjust the distances. The application of this new chromatography principle to the isolation of lectins is discussed and it is shown that several members of this family of protein can be eluted from affinity columns with deionized water. The merits of affinity-repulsion chromatography are discussed and some of its potential applications are presented. ISA

N91-22689# Bar-Ilan Univ., Ramat-Gan (Israel). Dept. of Chemistry.

BIOMATERIAL INTERACTIONS WITH ORGANIZED SURFACES Abstract Only

Shmuel Margel and D. Y. Sogah *In* Weizmann Inst. of Science, 8th International Symposium on Affinity Chromatography and Biological Recognition: Program and Abstracts 3 Nov. 1989 1 p (For primary document see N91-22681 14-51)

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Contact between polymeric surfaces and blood may induce thromosis, complement activation or electrolyte depletion. The factors controlling this interaction are not well understood. An approach to elucidating the influence of various functional groups on the interaction of biomaterials with surfaces has been developed. It involves studying the interaction of defined peptides and cells with organized, close-packed monolayer surfaces composed of a variety of functional groups, e.g., -CH2OH, -CO2Me, -CH3 and -CF3, and the omega position. These surfaces were prepared through the self-adsorption of alpha, omega amphiphiles of the type SiCl3(CH2)1-x (where x = CH3, CH2CO2Me, CF3, etc.) onto appropriate solid substrates. Characterization of these surfaces by techniques, such as ESCA, ellipsometry, FTIR-ATR and surface tension measurements, demonstrated that they are composed of fully extended molecules that cover most, if not all, of the solid substrates. The main conclusions are: that endothelial cells attach themselves and grow on the monolayer surfaces, according to the following decreasing order: -CH20H, -CO2Me, -CH3, -CF3 and that the adsorption of proteins at the interface between the water solution and the monolayer surfaces depends on both the surface and the proteins. The degree of adsorption at the surfaces descends in the order: -CH3, -CF3, -CO2Me, -CH2OH. The degree of adsorption also increases with increasing protein hydrophobicity. ISA

N91-22690# Technion - Israel Inst. of Tech., Haifa. Dept. of Biomedical Engineering.

OXIDATIVE PROCEDURE FOR ACTIVATION OF HYDROXYL-CONTAINING POLYMERIC CARRIERS Abstract Only

Rosa Azhari, A. Seidel, L. Bauch, S. Sideman, and Noah Lotan *In* Weizmann Inst. of Science, 8th International Symposium on Affinity Chromatography and Biological Recognition: Program and Abstracts 3 Nov. 1989 1 p (For primary document see N91-22681 14-51)

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Immobilized bioactive materials have reached wide use in a variety of biotechnological processes. They are prepared using appropriate carriers (soluble or insoluble). The most frequently used of these carriers are the ones containing hydroxy groups. Many procedures have been suggested for activation of hydroxyl-containing carriers. The most efficient ones involve the use of cyanogen bromide, carbonyldiimidazole (CDI), sulfonyl chlorides, or fluoro methylpyridinium toluene sulfonate (FMP). These methods, however, have limitations concerning either the stability of the bond formed, the cost of the reagents, or the convenience of the procedure involved. In this report, a convenient and efficient method for activation of hydroxyl-containing polymeric carriers is presented. It involves the dimethyl sulfoxide-acetic anhydride oxidation (DAO) of the hydroxyl groups on the polymeric carriers, converting them into aldehyde groups. Bioactive materials, carrying an amine moiety, can then be attached to the activated matrix, via an imine linkage. The suggested activation is carried out under mild conditions. The use of the DAO procedure to activate a soluble polysaccharide (inulin), an insoluble polysaccharide (Sepharose) and a modified ceramic carrier (glycerol modified controlled pore glass) was investigated. It was found that the degree of oxidation is related to the duration of the reaction. Thus, when inulin was used as carrier, oxidation periods of five and 48 hours produced 0.3 and 1.6 mmole aldehyde/gr product, respectively. Efficiency of the DAO procedure was assessed using Sepharose as carrier. Thus, under chosen conditions, 3.8 mg tyramine were bound per gr produce. This value is similar to that obtained under optimal conditions using FMP activation (4 mg/gr product), and higher than when using CDI (1.8 mg/gr product). The above reagents show the same order of efficiency when immobilizing an enzyme, namely beta-glucosidase. Author (ISA)

N91-22691# Tel-Aviv Univ. (Israel). Dept. of Biotechnology.

EUPERGIT C AS A CARRIER FOR HPLC-BASED IMMUNO-PURIFICATION OF ANTIGENS AND ANTIBODIES Abstract Only

Gideon Fleminger, Tamar Wolf, Eran Hadas, and Beka Solomon *In* Weizmann Inst. of Science, 8th International Symposium on Affinity Chromatography and Biological Recognition: Program and Abstracts 3 Nov. 1989 1 p (For primary document see N91-22681 14-51)

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In investigating the applicability of Eupergit C (EC)-immobilized antibodies and antigens to immunopurification, various enzymatically active proteins were used as antigens, and corresponding monoclonal antibodies mAbs were selected which did not inhibit the enzymatic activity of these antigens. Binding of the antigen by the matrix-immobilized antibody could thus be monitored by direct measurement of the enzymatic activity of the matrix-bound immunocomplex. This approach made possible the determination of the antigen binding activity of the conjugated antibodies at very high sensitivity. An immunopurification system, based on the EC-immobilized antibodies was found to be highly selective, reproducible and stable. EC beads of 30 u (C30N) were found to be most suitable for high performance liquid chromatography (HPLC) purification, demonstrating high antigen (or antibody) binding activity by the corresponding immobilized antibody (or antigen) and high peak performance. EC beads of 150 u, were found to be more suitable for conventional (non-HPLC)

immuno-affinity purifications. EC beads of 1 u (C1Z) had lower capacity for protein binding to the matrix but antibodies bound to this matrix showed higher antigen binding activity than the 30 u and the 150 u beads, apparently owing the non-porous nature of this matrix. EC is characterized by high chemical and mechanical stability and stable protein-matrix linkage. Thus, an immunoaffinity purification cycle which included loading of an antigen-containing solution on a column at neutral pH and elution at higher pH may be repeated many times. This was shown with an immunopurification of a human decidua protein (HDP71) which was purified from seminal plasma by C3ON-immobilized specific mAbs, using a HPLC system equipped with an autoinjector. Over 200 cycles of purification were applied without any loss in column capacity or performance. ISA

N91-22692# Tel-Aviv Univ. (Israel). Dept. of Biotechnology.
REDUCTION OF NONSPECIFIC ADSORPTION OF SERUM PROTEINS TO EUPERGIT C AND AGAROSE Abstract Only
Gideon Fleminger, Tamar Wolf, Beka Solomon, and Eran Hadas *In* Weizmann Inst. of Science, 8th International Symposium on Affinity Chromatography and Biological Recognition: Program and Abstracts 3 Nov. 1989 1 p (For primary document see N91-22681 14-51)
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In an attempt to reduce non-specific adsorption of proteins to insoluble matrices during affinity chromatography, the effect of polyethylene glycol (PEG) on protein adsorption to Eupergit C (EC) and to agarose was studied. Oxirane-blocked EC was prepared by reaction of the matrix with 2-mercaptoenthanol (2-ME). Serum samples (0.01-1.0 ml) were applied to columns packed with the 2-ME-blocked EC (2-M3-EC) or non-modified agarose. The amount of protein adsorbed onto the columns and eluted with SDS/urea solution or with 0.2 M ammonium acetate buffer, pH 10.00, was determined by monitoring the adsorbance at 280 nm. In these studies, it was found that addition of PEG (400 or 1500) to the PBS buffer during the loading step of the serum reduced the amount of protein adsorbed to 2-ME-EC by about 90 percent. This effect was attributed to the increase in hydrophilicity of the matrix by the presence of PEG. A 'memory effect' was also observed: when PEG was removed from the matrix, its effect in reducing adsorption was still retained for 3-5 additional loading/elution cycles. In contrast to EC, when PEG was included in the loading buffer of serum onto the agarose column, protein adsorption increased by about 6-fold and no 'memory effect' was observed. Covalent binding of diamino PEG 1500 to EC and to epoxy-activated Sephrose resulted in modified matrices which showed a very low degree of protein adsorption even when PEG was eliminated from the loading buffer. Inclusion of PEG into the loading buffer during immunopurification process of a serum protein (IgG) or seminal plasma protein (human decidual protein HDP71) as well as the purification of these proteins on PEG-modified EC resulted in a marked improvement in the purity of these proteins eluted from the respective columns. ISA

N91-22693# Tel-Aviv Univ. (Israel). Dept. of Biotechnology.
ENZYMATIC OXIDATION OF MONOCLONAL ANTIBODIES BY IMMOBILIZED BI-FUNCTIONAL ENZYME COMPLEXES Abstract Only
Beka Solomon, Rela Koppel, Fidi Schwartz, and Gideon Fleminger *In* Weizmann Inst. of Science, 8th International Symposium on Affinity Chromatography and Biological Recognition: Program and Abstracts 3 Nov. 1989 1 p (For primary document see N91-22681 14-51)
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Site-specific modification of antibodies by oxidation with sodium periodate as a means for their oriented immobilization onto insoluble matrices is widely used. However, many antibodies are extremely sensitive to periodate oxidation and may lose their antigen-binding activity by this treatment. An alternative approach adopted by us was the enzymatic oxidation of the carbohydrate moieties of the antibodies. These residues, which are located remote from the antigen binding sites of the antibody, are composed of 0-1 residues of fucose, 3 of mannose, 1-2 of galactose, 3-4 of N-acetylglucosamine and 0-3 residues of sialic acid. The last is always a terminal sugar residue and may be removed by treatment with neuraminidase. Penultimate galactose residues may then be enzymatically oxidized by galactose oxidase to form corresponding aldehyde groups required for coupling to the carrier. Neuraminidase and galactose oxidase were oxidized by treatment with sodium periodate and co-immobilized onto adipicdihydrazine-modified Eupergit C (ADH-EC). The immobilized enzymes retained high activity and showed high stability under operational conditions. The enzymatic bifunctional complex obtained oxidized monoclonal antibodies very efficiently and selectively without impeding the immunological activity of the antibodies. The antigen-binding activities of monoclonal antibodies immobilized after enzymatic oxidation proved to be higher than those of the same antibodies immobilized after periodate oxidation, and was close to the theoretical value of 2 mole antigen per mole of bound antibody. Author (ISA)

N91-22694# Tel-Aviv Univ. (Israel). Dept. of Biotechnology.
ADIPIC DIHYDRAZIDE-EUPERGIT C: A NEW DERIVATIVE FOR ORIENTED IMMOBILIZATION OF MONOCLONAL ANTIBODIES Abstract Only
Beka Solomon, Eran Hadas, and Gideon Fleminger *In* Weizmann Inst. of Science, 8th International Symposium on Affinity Chromatography and Biological Recognition: Program and Abstracts 3 Nov. 1989 1 p (For primary document see N91-22681 14-51)
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Eupergit C (EC) is a cross-linked synthetic copolymer based on methacrylamide, N-methylene bisacrylamide and monomers containing high numbers of oxirane groups which function as reactive moieties for the covalent binding of proteins via their amino, thio and hydroxy groups. Some biologically active proteins (e.g., certain monoclonal antibodies) are partially or completely inactivated after immobilization onto the matrix as a result of improper orientation of the immobilized molecule or restriction induced by multi-point attachment of the protein molecule to the surface of the matrix. This was exemplified by the binding to EC of a series of anti-carboxypeptidase A (CPA) antibodies which are characterized after immobilization by low antigen binding activity. An alternative approach to the binding of the same mAbs to EC via the carbohydrate moieties was modification of oxirane groups to hydrazide or amino groups. Treatment of EC with hexamehylene diamine (HMD) or adipic acid dihydrazide (ADH) led to new derivatives suitable for an oriented immobilization of mAbs in particular and glycoproteins in general. Binding of mAbs to hydrazide modified carrier was carried out by a multi-step procedure including oxidation of the mAbs by sodium periodate, removal of excess of reagent and coupling of the protein to the modified carrier. Owing to the stable chemical composition of EC, a single step oxidation procedure was developed where oxidation of antibodies and binding to the matrix are performed concomitantly. Highly active antibody preparations were thus obtained which possessed about two fold higher antigen binding activity than the same antibodies immobilized on unmodified EC via their amino groups. ADH-EC proved to be an excellent carrier for one- or multi-step coupling of oxidized mAbs, owing to its high chemical stability and high binding capacity. Author (ISA)

N91-22695# Tel-Aviv Univ. (Israel). Dept. of Biotechnology.
ENHANCED ACTIVITY OF IMMOBILIZED DIMETHYMALEIC ANHYDRIDE-PROTECTED POLY- AND MONOCLONAL ANTIBODIES Abstract Only
Eran Hadas, Rela Koppel, Fidi Schwartz, Osnat Raviv, and Gideon Fleminger *In* Weizmann Inst. of Science, 8th International Symposium on Affinity Chromatography and Biological Recognition: Program and Abstracts 3 Nov. 1989 1 p (For primary document see N91-22681 14-51)
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Immobilization of different antibodies onto solid supports usually results in partial or even complete loss of activity of the immobilized antibodies. Activity of some immobilized antibodies may be impaired even if the molecule is immobilized via sites which are close to

its active site. Such interference is unlikely when the site of interaction of the protein with carrier is remote from the active site of the protein. Another possible mechanism for loss of activity of immobilized antibodies is impairment of intramolecular mobility which may follow multi-point attachment of the antibody to the carrier. Such effect would be dependent upon the number and distribution of reactive groups on the protein and on the carrier. Eupergit C is a polymethylmethacrylamide based carrier which is characterized by high content of reactive oxirane groups. The high density of reactive groups serves to increase the binding capacity of Eupergit C but also results in high multipoint attachment of antibodies. The application of reversible blocking of free amines with dimethylmaleic anhydride (DMA) in order to reduce multipoint attachment of antibodies to the carrier and thus improve the activity of the immobilized antibodies was investigated. The results obtained demonstrated a marked improvement in activity of immobilized poly- and monoclonal antibodies which were coupled to the matrix, following blocking of their free amines with DMA. Author (ISA)

N91-22696# BioTechnology General, Rehovot (Israel). Dept. of Biochemistry.
CHAPS BOOSTS THE RECOVERY OF HYDROPHOBIC MEMBRANE PROTEINS FROM VARIOUS CHROMATOGRAPHY MEDIA Abstract Only
Nachum Reiss, Iris Yoshpe, Allon Bogin, and Moshe M. Werber *In its* 8th International Symposium on Affinity Chromatography and Biological Recognition: Program and Abstracts 3 Nov. 1989 1 p (For primary document see N91-22681 14-51)
Copyright Avail: NTIS HC/MF A07

Hydrophobic groups are usually involved in the structure of matrices for various chromatographic methods. These groups cause non-specific interactions with proteins, and especially hydrophobic proteins, reducing their recovery during purification. Another detrimental effect is that the elution profile of the separated proteins may be shifted from that expected from their physico-chemical properties relevant to the chromatographic matrix in use. From the first chromatographic step, established by Muira et al. (1987), for the purification of membranal ADPase in the presence of Triton X-100, the recovery of ADPase activity was found to be very low, due to both irreversible binding to the DEAE-Sepharose matrix and sensitivity to the detergent. To overcome these problems, Triton X-100 was replaced with the zwitterionic detergent CHAPS, which was used at a concentration of 0.3 percent or more in all the purification steps: ion exchange chromatography (DEAE-Sepharose), hydrophobic chromatography (phenyl-Sepharose), metal chelate affinity chromatography (iminodiacetic acid-agarose) and molecular sieving (Superose 12). These concentrations of CHAPS boosted the recovery of ADPase activity from 20-30 percent at each step to 80-100 percent, and enabled the purification of significant amounts of the membranal protein. Author (ISA)

N91-22697*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CENTRIFUGE FACILITY CONCEPTUAL SYSTEM STUDY. VOLUME 2: FACILITY SYSTEMS AND STUDY SUMMARY
Robert Synnestvedt, ed., Patricia Blair, Alan Cartledge, Jorge Garces-Porcile, Vladimir Garin, Mike Guerrero, Peter Haddeland, Mike Horkachuck, Ulrich Kuebler, and Frank Nguyen et al Mar. 1991 458 p
(NASA-TM-102860; NAS 1.15:102860) Avail: NTIS HC/MF A20 CSCL 06C

The Centrifuge Facility is a major element of the biological research facility for the implementation of NASA's Life Science Research Program on Space Station Freedom using nonhuman species (small primates, rodents, plants, insects, cell tissues, etc.). The Centrifuge Facility consists of a variable gravity Centrifuge to provide artificial gravity up to 2 earth G's' a Holding System to maintain specimens at microgravity levels, a Glovebox, and a Service Unit for servicing specimen chambers. The following subject areas are covered: (1) Holding System; (2) Centrifuge System; (3) Glovebox System; (4) Service System; and (5) system study summary. Author

N91-22698# Marine Biological Lab., Woods Hole, MA.
METHODS IN COMPUTATIONAL NEUROSCIENCE Final Course Report, 5 Aug. - 1 Sep. 1990
James M. Bower and Christof Koch 1 Sep. 1990 11 p
(Contract N00014-90-J-1965)
(AD-A231397) Avail: NTIS HC/MF A03 CSCL 05/6

The 1990 version of the course enrolled a total of 22 students including three tenured faculty members for the first time. Digital Equipment Corporation provided the course with 25 DECstation 5000/200s which provided more than ample computer capability. Each student was assigned to their own workstation which assured access to computing resources at all times. The range of course projects undertaken in the computer lab this year was also excellent (see Appendix A). In general it was found that students were able to advance their models considerably further than in previous years. This particularly reflects two years of experience teaching students how to use the GENESIS simulator, and also reflects the fact that a growing number of students have already had some experience with neural simulations (and even GENESIS) before entering the course. GRA

N91-22699# Technische Univ., Eindhoven (Netherlands).
NAD(+)-NADH MODELLING STUDIES: AN ENZYMATIC AND CHEMICAL APPROACH Ph.D. Thesis
Nicoline Annette Beijer 1990 99 p
(ETN-91-99175) Avail: NTIS HC/MF A05

Chemical and enzymatic studies on the coenzyme NAD+ and its reduced form NADH are reported. In combination with specific enzymes (dehydrogenases) the coenzyme is involved in the reversible stereospecific dehydrogenation of many substrates. Major focus is on the modeling of the coenzyme, but the relation between enzyme and coenzyme is also elucidated by modifying the enzyme structure in its active site. Using molecular mechanics a number of mutated HLADH's are stimulated in order to select those amino acid residues which substantially affect the coenzyme geometry. The methodology developed may be helpful in selecting targets for site directed mutagenesis in order to genetically engineer HLADH so as to optimize the interaction of the apo-enzyme and coenzyme. ESA

N91-22700# Stockholm Univ. (Sweden). Inst. of Physics.
METALS IN BIOLOGY: TECHNICAL DETAILS OF QUANTUM CHEMICAL AB INITIO CALCULATIONS ON FERROUS AND FERRIC IRON-BIS-GLYOXAL AND IRON-BIS-DITHIOLENE
I. Fischer-Hjalmars and H. Holmgren 22 Mar. 1989 42 p
(USIP-89-01; ETN-91-99242) Avail: NTIS HC/MF A03

Quantum chemical laboratory investigations aiming at a study of the binding between metal and ligand in biosystems, and electronic aspects governing biochemical reactions, including charge transfer, are addressed. The influence of an aqueous or other surrounding medium must be considered for small model complexes in vacuum. The first step of a stepwise approach, first to study the central complex as such, and at a later stage to introduce some kind of discrete model of the surrounding, is discussed. Results obtained for iron complexes with either oxygen or sulfur as ligand forming atoms are presented. ESA

N91-22701# Helsinki Univ. (Finland). Div. of Physiology.
ROLE OF BICARBONATE IN THE ACTIONS OF GAMMA-AMINOBUTYRIC ACID (GABA) ON MEMBRANE CONDUCTANCES, CURRENTS, AND pH REGULATION IN EXCITABLE CELLS Ph.D. Thesis - Helsinki Univ. of Technology
Juha Voipio Helsinki, Finland Finnish Academy of Technical Sciences 1990 69 p Sponsored by Finnish Academy of Technical Sciences, Helsinki and Jenny and Antti Wihuri Foundation
(Acta-Polytec-Scand-Ph-172; ISBN-951-666-321-4; ISSN-0355-2721; ETN-91-99259) Avail: NTIS HC/MF A04

Ion selective microelectrodes and a two or three microelectrode voltage or current clamp were used to examine the effects of inhibitory neurotransmitter Gamma Amino Butyric Acid (GABA) on intracellular pH (pH(i)) extracellular surface pH (pH(s)) intercellular

chloride activity (a(i)Cl) as well as on membrane potential, current and conductance in crayfish muscle fibers and the Stretch Receptor Neurone (SRN). In the muscle, a near saturing concentration of GABA induced the following channel mediated, HCO(-)(a(i)Cl) dependent effects: a depolarizing inward current, a rise in (a(i)Cl) and (pH(s)) and a fall in (pH(i)). Substitution of 30 mmol/l of Cl(-) by HCO(-)(a(i)Cl) brought about a (pH(i)) dependent positive deviation of the reversal potential of the GABA induced current (E(GABA)) from the equilibrium potential of Cl(-)(E(Cl)). Experiments on the SRN gave very similar results. Measurements of (E(GABA)) yielded a value of about 0.3 for the relative permeability of HCO(-)(a(i)Cl) versus Cl(-) in the GABA channel. Experiments with carboxymate anions indicated that the effective diameter of the GABA gated channel in the muscle fiber is about 0.5 nm which is close to the value measured in mammalian GABA(A) channels. The present results show that the widely accepted equivalence of E(CL) and (E(GABA)) is not valid under physiological conditions, and that there is a bidirectional link between actions of GABA and regulation of pH. Application of linear cable theory as well as thermal design of electrometer amplifiers are also discussed.
ESA

N91-22702# Los Alamos National Lab., NM.
GRUNEISEN-STRESS INDUCED ABLATION OF BIOLOGICAL TISSUE
R. S. Dingus and R. J. Scammon 1991 11 p Presented at the 4th Society of Photo-Optical Instrumentation Engineers (SPIE) International Symposium, Los Angeles, 20-25 Jan. 1991
(Contract W-7405-eng-36)
(DE91-009957; LA-UR-91-905; CONF-910123-19) Avail: NTIS HC/MF A03

The objective of biomedical applications of lasers is frequently to remove tissue in a controlled manner. However, for ablation induced by thermal- or photo-decomposition, damage to surrounding tissue may be excessive in some instances. Tissue can also be ablated by a hydrodynamic process referred to as front surface spallation, in which a thin layer next to a free surface is heated to levels, below vaporization but, so rapidly that it cannot undergo thermal expansion during laser heating. This generates a stress pulse, which propagates away from the heated region, with an initial amplitude that can be calculated using the Grueneisen coefficient. As the pulse reflects from the free surface, a tensile tail can develop of sufficient amplitude, exceeding the material strength, that a layer will be spalled off, taking much of the laser-deposited energy with it. Because tissue is generally a low strength material, this process has the potential of producing controlled ablation with reduced damage to the remaining tissue. However, to achieve these conditions, the laser pulse length, absorption depth and fluence must be properly tailored. This paper presents hydrodynamic calculations and analytical modeling relating to both stress- and thermal-induced ablation as a function of laser and tissue properties to illustrate the potential benefits of stress induced ablation. Also, guidance is given for tailoring the exposure parameters to enhance front surface spallation.
DOE

N91-22173*# Fielder (Judith), Reston, VA.
A HYDROPONIC DESIGN FOR MICROGRAVITY AND GRAVITY INSTALLATIONS
Judith Fielder and Nickolaus Leggett (Leggett, Nickolaus, Reston, VA) *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 436-439 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 06C

N91-22175*# Wake Forest Univ., Winston-Salem, NC. School of Medicine.
CHARACTERIZATION OF BLOOD DRAWN RAPIDLY FOR USE IN BLOOD VOLUME EXPANSION STUDIES: AN ANIMAL MODEL FOR SIMULATED WEIGHTLESSNESS
V. Michelle Chenault, Colleen D. Lynch, Mariana Morris, Jill Clodfelter, and Phillip M. Hutchins *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 460-467 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 06C

N91-23028*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
BIOMEDICAL APPLICATIONS OF NASA TECHNOLOGY
Donald S. Friedman *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 63-65 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 06C

52 AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

N91-22703*# Texas Univ., El Paso. Dept. of Electrical Engineering.
INTERDISCIPLINARY INVESTIGATIONS IN SUPPORT OF PROJECT DI-MOD Semiannual Progress Report, Sep. 1990 - Apr. 1991
Scott A. Starks 1991 61 p
(Grant NAG2-670)
(NASA-CR-188098; NAS 1.26:188098) Avail: NTIS HC/MF A04 CSCL 06P

Interdisciplinary investigations in support of project DI-MOD are discussed. The following subject areas were covered: (1) potential extensions of Project DI-MOD to additional sites in Central America; (2) human migration patterns and their impact on malaria transmission; and (3) an investigation into possible computer-based approaches to the analysis of remotely sensed multispectral data.
Author

N91-22704*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
INDEX OF MATERIAL SAFETY DATA SHEETS: TOXIC SUBSTANCES REGISTRY SYSTEM
Apr. 1991 696 p
(NASA-GP-23-1; NAS 1.2:23-1) Avail: NTIS HC/MF A99 CSCL 06E

The Material Safety Data Sheets (MSDSs) listed in this index reflect product inventories and associated MSDSs which have been submitted to the Toxic Substance Registry database maintained by the Base Operations Contractor at the Kennedy Space Center. The purpose of this index is to provide a means to access information on the hazards associated with the toxic and otherwise hazardous chemicals stored and used at the Kennedy Space Center.
Author

N91-22705# Cambridge Univ. (England). Dept. of Experimental Psychology.
ACQUISITION AND PROCESSING OF INFORMATION DURING STATES OF RAPID EYE MOVEMENT (REM) SLEEP AND SLOW-WAVE SLEEP Final Report, Mar. - Jun. 1989
John D. Molton Jul. 1990 29 p
(Contract DAJA45-89-M-0125)
(AD-A231772; R/D-6231-RB-09) Avail: NTIS HC/MF A03 CSCL 05/8

This report reviews, analyzes, and summarizes experimental literature on 'sleep learning.' Findings are as follows: (1) Serious methodological flaws were found in all reported positive results. There is no evidence that semantic learning occurs when verbal material is presented to sleeping subjects. (2) A critical, but open-minded, test of sleep learning has not been done. Recommendations are made for an appropriate experiment. (3) If new material is presented to the sleeping subject, there is danger that it may interfere with normal nighttime processing of earlier daytime experiences.
GRA

N91-22706# Army Aeromedical Research Lab., Fort Rucker, AL.
CODING MANUAL FOR THE US ARMY AVIATION EPIDEMIOLOGY DATA REGISTER
Thomas J. Burke and Renee Kingsley Jan. 1991 59 p
(AD-A231885; USAARL-91-4) Avail: NTIS HC/MF A04 CSCL 05/9

The U.S. Army Aviation Epidemiology Data Register (AEDR) is an automated database which allows electronic storage, analysis, and retrieval of information of the Flying Duty Medical Examination (FDME). The FDME consists of a completed Report of Medical History (standard form (SF) 93), Report of Physical Examination (SF 88), Report of Electrocardiogram SF 520) with the electrocardiogram tracing, and for certain classes of FDME, additional information on lifestyle factors and family history. Demographic data, patient history, physician history, physical findings, screening tests, and diagnoses information are included on these forms, each of which has a unique value in health care, administration, and research, and each of which must be handled differently in the AEDR. Demographic and screening test results are entered directly from the FDME to the AEDR. History, physical findings, and diagnoses are translated into a standardized alphanumeric code, a modification of the International Classification of Diseases (ICD). Because of the unique characteristics of the military aviation environment, the ICD is inadequate to support all the clinical, administrative, and research functions of the AEDR. The ICD has been supplemented with additional diagnostic codes to provide extra specificity, codes for physical findings and electrocardiograms, and codes to automate the administrative process. These codes are discussed. GRA

N91-23030*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
X RAY IMAGING MICROSCOPE FOR CANCER RESEARCH
Richard B. Hoover, David L. Shealy, B. R. Brinkley, Phillip C. Baker, Troy W. Barbee, Jr., and Arthur B. C. Walker, Jr. (Stanford Univ., CA.) *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 73-82 (For primary document see N91-23021 14-99)
(Contract NsG-5131; W-7405-eng-48)
Avail: NTIS HC/MF A18 CSCL 14B

N91-23031*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MECHANICAL RESPONSE TISSUE ANALYZER FOR ESTIMATING BONE STRENGTH
Sara B. Arnaud, Charles Steele, and Anthony Mauriello (GaitScan, Inc., Ridgewood, NJ.) *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 83-88 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 14B

N91-23032*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ADAPTATION OF NASA TECHNOLOGY FOR THE OPTIMIZATION OF ORTHOPEDIC KNEE IMPLANTS
D. A. Saravanos, P. J. Mraz (Case Western Reserve Univ., Cleveland, OH.), and D. A. Hopkins *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 89-98 (For primary document see N91-23021 14-99)
(Grant NAG3-1027)
Avail: NTIS HC/MF A18 CSCL 05H

N91-23066*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
URODYNAMIC PRESSURE SENSOR
Thomas Moore *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 363-369 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 14B

53 BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

N91-22707# Stanford Univ., CA. Dept. of Psychology.
DECISION UNDER CONFLICT Annual Report, No. 2, 1 Dec. 1989 - 30 Nov. 1990
Amos Tversky 21 Nov. 1990 12 p
(Grant AF-AFOSR-0064-89; AF Proj. 2313)
(AD-A231109; AFOSR-90-1216TR) Avail: NTIS HC/MF A03 CSCL 05/8

The present report summarizes two projects. The first project, which focuses on riskless choice, involves a series of experiments that demonstrate the phenomenon of loss aversion: losses and disadvantages have greater impact on preference than gains and advantages. The evidence shows that choice depends on the status quo or reference level, and that changes of reference point often lead to reversals of preference. To account for these observations, we develop a reference-dependent theory of individual choice, which explains such effects by a deformation of the preference map about the reference point. Implications of loss aversion to both individual and aggregate behavior are explored. The second project, which focuses on decision under uncertainty, extends prospect theory by incorporating a cumulative (i.e., rank-dependent) weighting scheme. In this model, the carriers of value are gains and losses, defined relative to a reference point, and the impact of uncertainty is summarized by different weighting functions for gains or for losses. Two evaluation principles -- diminishing sensitivity and loss aversion are invoked to explain the characteristic curvature of the value function and the weighting functions. A review of the experimental evidence and the results of a new experiment reveal a distinctive four-fold pattern of risk attitudes: risk aversion for gains and risk seeking for losses of high probability; risk seeking for gains and risk aversion for losses of low probability. Author

N91-22708# British Columbia Univ., Vancouver. Dept. of Psychology.
PSYCHOLOGICAL ANALYSES OF COURAGEOUS PERFORMANCE IN MILITARY PERSONNEL Interim Report No. 2, Dec. 1987 - Dec. 1988
S. Rachman Aug. 1990 32 p
(Contract DAJA45-87-C-0009)
(AD-A231774; R/D-4158A-RB-01) Avail: NTIS HC/MF A03 CSCL 05/9

This research reports on the second year of the project to identify psychological markers of courageous military performance. Findings indicate that means and standard deviations of heartrate responses of 28 bomb disposal operators during a lab stress test are similar to patterns recorded for previous groups of operators. Individual profiles were constructed for each operator. Physiological and psychometric data for the operators are internally consistent, but weakly correlated with each other. Preliminary analyses indicate that, as expected, low anxiety and heartrate activity is associated with superior performance in the field. Moreover, decorated operators responded stably and without anxiety during pre-tour stress tests. Early results on optimism and courage form no clear pattern. GRA

N91-22709# Wright State Univ., Dayton, OH. Human Factors Engineering.
THE ROLE OF TRAINING, INDIVIDUAL DIFFERENCES AND KNOWLEDGE REPRESENTATION IN COGNITIVE-ORIENTED TASK PERFORMANCE Interim Report, 1 Nov. 1989 - 31 Oct. 1990
Richard J. Koubek Dec. 1990 24 p
(Contract N00014-90-J-1256)
(AD-A231798) Avail: NTIS HC/MF A03 CSCL 05/8

This research examines the impact of training style, individual differences and task representation on automatized task performance and controlled task performance. Results indicate that performance on relatively straightforward repetitive tasks,

usually associated with automatization, is influenced by training style and the mental task representation held by individuals. Also, task representation is a significant determinant of performance on complex cognitive-oriented tasks (i.e., controlled process tasks). Therefore, the task representation is suggested as a high level determinant for both simple and complex task performance. No effect for individual differences was found. It is concluded that training programs and task design for these type of activities must account for the representation in an effort to maximize individual performance. GRA

N91-22710# Army Research Inst. for the Behavioral and Social Sciences, Alexandria, VA.
THE SELECTION OF AN EXPERIMENTAL TEST BATTERY FOR AVIATOR COGNITIVE, PSYCHOMOTOR ABILITIES, AND PERSONAL TRAITS Interim Report, Jan. - Jul. 1987
Gabriel P. Intano, William R. Howse, and Ronald J. Lofaro Jan. 1991 29 p
(AD-A231887; ARI-RN-91-21) Avail: NTIS HC/MF A03 CSCL 05/8

In late 1986, the U.S. Army Aviation Center (USAAVNC) redesigned the Initial Entry Rotary Wing (IERW) course for aviator candidates. The new training is called IERW Multitrack (IERW-MT) and became operative in May 1988. The research problem for the U.S. Army Research Institute Aviation R&D Activity (ARIARDA) was to develop tests and procedures for selecting aviator candidates for one of four helicopters prior to training day 100. ARIARDA simultaneously pursued two avenues of research. On the one hand, available test instruments were considered and evaluated for their potential to discriminate among aviators. On the other hand, groups of Subject Matter Experts (SMEs) developed criticality-rated aviator candidate abilities and traits for specific operational helicopters. Extensive literature reviews and liaison with sister services and other agencies were accomplished. Four test instruments were evaluated for use. The underlying abilities, traits, and skills these batteries purported to measure matched the abilities, traits, and skills identified as necessary by the SMEs for each of their helicopters. Upon selection of the subjects contained in the ARIARDA experimental test battery, high-time aviators were given the experimental battery to develop scoring profiles for specific aircraft and to generate the data for the statistical analyses that resulted in the Preliminary Multi-Track Classification Algorithm. GRA

N91-22711# Los Alamos National Lab., NM.
LINKING STRUCTURE AND FUNCTION: INFORMATION PROCESSING IN THE BRAIN
M. A. V. Gremillion 1990 24 p Presented at the 1990 Santa Fe Institute Summer School on Complex Systems, Santa Fe, 12-16 Jun. 1990
(Contract W-7405-eng-36)
(DE91-009946; LA-UR-91-829; CONF-9006299) Avail: NTIS HC/MF A03

Traditionally, theories of function in neuroscience have emerged from physiology. Physiologists have suggested a number of means by which information in the brain can be processed, yet the principles underlying the generation of these phenomena are not well understood. A complex systems approach would be to examine the overall structure and function of the system and to attempt to establish a common framework for information processing interactions. This paper will use the structure-function relationship as a basis for exploring units of information processing. It will examine the brain as a whole, first providing the non-specialists with an short overview of the structure and some of the functions or outputs of the brain. It then very briefly reviews three of the prominent theoretical concepts that have emerged in the last few decades: receptive fields, feature extraction, and parallel processing. Next, it addresses the question of information processing and outlines the structures which have traditionally been proposed to be the basic unit of information processing. An alternative unit on which information processing in the brain might be based is then proposed, and data outlined to support it. Finally, the implications of this different mode of processing are discussed, both for the brain and for other complex systems. DOE

N91-22885# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.).
ASTRONAUT TRAINING [ASTRONAUTENTRAINING]
Renate Bruemmer *In its* Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 13-20 In ENGLISH and GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

For related information see also *16 Space Transportation.*

N91-22712# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
A COMPARISON OF HUMAN-COMPUTER INTERFACES IN AIR FORCE ORGANIZATIONS M.S. Thesis
Michael G. Morris Dec. 1990 140 p
(AD-A229708; AFIT/GIR/LSM/90D-7) Avail: NTIS HC/MF A07 CSCL 23/2

This thesis investigated differences in organizational efficiency and effectiveness for users of graphical user interfaces and text-based interfaces on personal computers in Air Forces offices. Areas of interest included amount of time required to learn the basic system, amount of time required to learn new application, users' ratings of user-friendliness, users' perceptions of the extent that their system help them perform in their job, the number of software packages used on the job by users of each system, user satisfaction, responsible authorities' ratings of quality of output, and the relationship between user job experience level and interface used on the job. A literature review revealed no similar studies within the Department of Defense to date. Two populations across two organizations were identified for survey administration--users of graphical user interfaces and users of text-based interfaces. A total of 700 surveys were out with 454 returned for a response rate of 64.9 percent. The results of the study indicated that for the organizations surveyed, graphical user interfaces offer significant advantages in each of the areas investigated. Finally, the results of the study revealed that less experienced users tend to use graphical interfaces over text-based systems in greater numbers while civilian users were more likely to use text-based systems. GRA

N91-22713# Bristol Univ. (England). Dept. of Aerospace Engineering.
MILITARY AIR CREW HELMET DESIGN STUDY B.S. Thesis
A. P. Foley and G. R. McIlfatrick Jun. 1990 48 p
(BU-502; ETN-91-99195) Avail: NTIS HC/MF A03

Many current aircrew flying helmets are considered unsatisfactory by their users. By circulating a questionnaire among aircrew, a new specification was produced with the emphasis placed on their opinions and wishes. Apart from comfort criteria, fast jet and helicopter aircrew require differing helmet designs. For helicopter aircrew, protection and noise reduction are of greatest importance. Fast jet aircrew require above all a helmet which will not adversely affect their lookout capability either due to bulk, balance, weight, or field of view obstruction. In their opinion, protection is not of paramount importance. Helmet mounted systems are accepted as an operational requirement but present methods are considered unsatisfactory and system integration is a necessity. ESA

N91-22714 Tel-Aviv Univ. (Israel). Dept. of Interdisciplinary Studies.
AUTOMATED ANALYSIS OF FOOT-GROUND PRESSURE PATTERNS M.S. Thesis
Arie Rosengart Sep. 1988 103 p
(ITN-91-85092) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel

The Footprint instrument, which uses an optical interference sandwich to elucidate underfoot pressure distribution, provides a pictorial representation of the data; a measurement process is needed to determine the load forces numerically. This project aimed to develop a computerized, online image processing system for Footprint instrumental data, and to develop tools for offline analysis of foot ground-pressure (FGP) patterns, as related to foot structure. The processing algorithms were designed with particular attention to computation time economy. The main process implements image processing methods for the measurement of the interference fringes which form the FGP pattern. Appropriate conversion rules enabled these measurements to be translated into force; from the force distribution are computed the parameters which determine the foot-structure characteristics. To avoid the need to locate the centers of the approximately 150 fringes forming the FGP pattern, the system acquires an apriori knowledge of the standing plate and applies it during the measurement process. This approach reduced the measurement time for each pattern below 30 seconds, during which the following parameters are computed: force distribution; total load; load on each foot; contact area; average pressure; longitudinal arch; load and stress ratio for the forefeet and heels; and the points of peak load at the heels (sharpness). A utility program provides offline computation of the following additional parameters: FGP centroid; centroid of each foot or of any FGP segment; and average pressure in a selected segment.
ISA

N91-22249# MATRA Espace, Toulouse (France).
KNOWLEDGE BASED FRAMEWORK FOR MAN-SYSTEM INTERACTION IN SPACE CONTROL CENTRES
Francoise Carre, Pascal Richard, Nathalie Carn, and Nathalie Aussenac (Centre National de la Recherche Scientifique, Toulouse, France) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 373-378 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22270# Computer Resources International A/S (Denmark). Space Div.
THE DESIGN OF ERROR TOLERANT INTERFACES
Erik Hollnagel *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 511-514 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22281# VEGA Space Systems Engineering Ltd., Saint-Albans (England).
MAN-MACHINE INTERFACE (MMI) ASPECTS OF WORKSTATIONS FOR USE IN SPACECRAFT OPERATIONS
Roger S. Thompson *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 577-582 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22282*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
DEVELOPING A USER-INTERFACE-EVALUATION TOOL FOR SPACE-STATION-ERA APPLICATIONS
Shari A. Bahder, Elizabeth D. Murphy (Computer Technology Associates, Inc., Rockville, MD.), Sylvia B. Sheppard, and Walter Truszkowski *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 583-587 (For primary document see N91-22189 14-17)
(Contract NAS5-30680)
Copyright Avail: NTIS HC/MF A99 CSCL 05H

N91-22283# INTECS Toscana S.R.L., Pisa (Italy).
THE SCOS MAN-MACHINE INTERFACE PROJECT
Paolo Coppola and Bruno Mullet (European Space Agency. European Space Operations Center, Darmstadt, Germany, F.R.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 589-595 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22284# Marcol Computer Systems Ltd., Darmstadt (Germany, F.R.).
MSCC CONSOLE DEMONSTRATOR PROJECT
P. Hall and M. Drexler (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, Germany, F.R.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 597-600 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-23029*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
DIRECTION DISCRIMINATING HEARING AID SYSTEM
M. Jhabvala, H. C. Lin, and G. Ward (Design Three, Inc., Oxon Hill, MD.) *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 66-72 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 05H

N91-23065*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Robotic Hardware and Flight Experiments Group.
DIVERSE APPLICATIONS OF ADVANCED MAN-TELEROBOT INTERFACES
Douglas A. McAffee *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 350-360 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 05H

55 SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

N91-22715*# National Aeronautics and Space Administration, Washington, DC.
PUBLICATIONS OF THE EXOBIOLOGY PROGRAM FOR 1989: A SPECIAL BIBLIOGRAPHY
Mar. 1991 59 p Prepared in cooperation with George Washington Univ., Washington, DC
(Contract NASw-4324)
(NASA-TM-4269; NAS 1.15:4269) Avail: NTIS HC/MF A04 CSCL 06C

A listing of 1989 publications resulting from research supported by the Exobiology Program is presented. Research supported by the Exobiology Program is explored in the following areas: (1) cosmic evolution of biogenic compounds; (2) prebiotic evolution; (3) early evolution of life; (4) and evolution of advanced life. Pre-mission and pre-project activities supporting these areas are supported in the areas of solar system exploration and search for extraterrestrial intelligence. The planetary protection subject area is included here because of its direct relevance to the Exobiology Program.
Author

N91-22716*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
DEVELOPMENTAL ADAPTATIONS TO GRAVITY IN ANIMALS
Alan R. Hargens Feb. 1991 23 p
(NASA-TM-102228; A-89232; NAS 1.15:102228) Avail: NTIS HC/MF A03 CSCL 06B

Terrestrial animals have adapted to a constant gravitational stress over millions of years. Tissues of the cardiovascular system and lumbar spine in tall species of animals such as the giraffe are particularly well adapted to high and variable vectors of gravitational force. Swelling of the leg tissues in the giraffe is prevented by a variety of physiological mechanisms including (1)

a natural 'antigravity suit', (2) impermeable capillaries, (3) arterial-wall hypertrophy, (4) variable blood pressures during normal activity, and (5) a large-capacity lymphatic system. These adaptations, as well as a natural hypertension, maintain blood perfusion to the giraffe's brain. The intervertebral disk is another tissue that is uniquely adapted to gravitational stress. Tall and large terrestrial animals have higher swelling pressures than their smaller or aquatic counterparts. Finally, the meniscus of the rabbit knee provides information on the effects of aging and load-bearing on cartilaginous tissues. Such tissues within the joints of animals are important for load-bearing on Earth; these connective tissues may degenerate during long-duration space flight. Author

59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

No abstracts in this category.

60 COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware, and data processing.

For components see *33 Electronics and Electrical Engineering.*

N91-22717# Universiteit Twente, Enschede (Netherlands). Tele-Informatic Group.
ON THE DESIGN AND FORMAL SPECIFICATION OF A TRANSACTION PROCESSING PROTOCOL
Marten vanSinderen and Ing Widya Nov. 1990 23 p Sponsored by EEC
(MEMO-INF-90-66; ISSN-0923-1714; ETN-91-99136) Avail: NTIS HC/MF A03

The design and formal specification of a protocol that provides support for online transaction processing is presented. The design approach taken is one that supports stepwise refinement and incorporates formal methods based on the formal description technique LOTOS. The concepts of the design approach are explained and related to the design problem at hand. Three phases of the design are discussed: requirements capturing, the design of a service architecture, and the design of a protocol architecture. The two architectural designs illustrate a formal reflection of the OSI transaction processing model. They are expressed as compositions of LOTOS process instances. A report on the current status and future goals of the ongoing work on the completion of the component definitions is included. ESA

N91-22718# Universiteit Twente, Enschede (Netherlands). Dept. of Computer Science.
CISLAN ARCHITECTURE SECOND CYCLE
A. Pras and I. G. Niemegeers Nov. 1990 14 p Presented at 2nd International Conference on Local Communication Systems: LAN and PBX, Palma, Spain, 26-28 Jun. 1991 Revised
(MEMO-INF-90-67; MEMO-INF-90-19; CISLAN-90/UT-133; ISSN-0923-1714; ETN-91-99137) Avail: NTIS HC/MF A03

A distributed architecture for a future local integrated communication infrastructure is presented. The terms local and integrated mean that the functionality of the infrastructure is derived from the Integrated Services Digital Network (ISDN) user network interface standards. The term distributed indicates that the infrastructure avoids central components as much as possible. As a consequence, the role of the central component in a traditional infrastructure (the PABX) will be performed by a distributed Integrated Services (IS) PABX. The implementation of this IS-PABX is based upon existing asynchronous 802 local area networks (LAN's). The term architecture finally indicates that a framework or design approach, rather than a complete implementation is focused on. The idea is to distribute the functions of the IS-PABX by using existing IEEE 802 LAN's. The approach that is used is to design the architecture by using concepts that are similar to the ones used by the OSI community. ESA

N91-22719# Argonne National Lab., IL.
AN ASSESSMENT OF SCIENTIFIC COMPUTING TECHNOLOGY 1991-2001
C. J. Mueller, L. W. Amiot, T. R. Canfield, C. M. Caruthers, T. C. Kuhfuss, E. L. Lusk, R. J. McMahon, D. M. Malon, M. Minkoff, and F. M. Moszur et al Feb. 1991 58 p
(Contract W-31-109-eng-38)
(DE91-009819; ANL/TM-486) Avail: NTIS HC/MF A04

This report discusses the future computing technology at Argonne National Laboratory. Some of the areas covered are: computational science needs: the grand challenges; scientific computing hardware; software: languages and tools; FORTRAN and compilers for parallel computers; networking and communications; and scientific visualization. DOE

N91-22242# INTECS Toscana S.R.L., Pisa (Italy).
A POSSIBLE ARCHITECTURE OF A DISTRIBUTED HARD REAL-TIME EXECUTIVE FOR SPACE APPLICATIONS
S. Sabina and F. Fedi *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 323-329 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22272# Societe d'Etudes des Systemes d'Automation, Toulouse (France).
FIABAI: A KNOWLEDGE BASED SYSTEM FOR THE EVALUATION OF THE RELIABILITY-AVAILABILITY OF COMPLEX COMPUTER ARCHITECTURES
G. Jalfre, C. Levy, and F. Chabanne (Centre National d'Etudes Spatiales, Toulouse, France) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 521-525 In FRENCH (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22316*# Purdue Univ., West Lafayette, IN.
OPTIMAL CONTROLLERS FOR FINITE WORDLENGTH IMPLEMENTATION
K. Liu and R. Skelton *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 91-132 (For primary document see N91-22307 14-18)
(Grant NAG1-857)
Avail: NTIS HC/MF A20 CSCL 09B

N91-23025*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
HYPERCUBE TECHNOLOGY
Jay W. Parker, Tom Cwik, Robert D. Ferraro, Paulett C. Liewer, and Jean E. Patterson *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 31-41 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09B

N91-23033*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
OPTICAL STORAGE DEVICE
Sharon S. Welch *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 101-108 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09B

N91-23034*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
REWRITEABLE OPTICAL DISK RECORDER DEVELOPMENT
Thomas A. Shull and Pamela L. Rinsland *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar.

1991 p 109-118 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09B

61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, alogorithms, and specific applications, e.g., CAD/CAM.

N91-22720*# Houston Univ., Clear Lake, TX. Software Engineering Professional Education Center.
DESIGN SOFTWARE FOR REUSE
Will Tracz (IBM Federal Systems Div., Owego, NY.) 7 Nov. 1990 81 p Presented at a Symposium on Software Engineering, Houston, TX, 1990
(Contract NCC9-16)
(NASA-CR-187917; NAS 1.26:187917) Avail: NTIS HC/MF A05 CSCL 09B

Viewgraphs are presented on the designing of software for reuse. Topics include terminology, software reuse maxims, the science of programming, an interface design example, a modularization example, and reuse and implementation guidelines. Author

N91-22721*# Maryland Univ., College Park. Dept. of Computer Science.
SUPPORT FOR COMPREHENSIVE REUSE
V. R. Basili and H. D. Rombach Feb. 1991 41 p
(Contracts NsG-5123; N00014-87-K-0307; Airmics-19K-CN983-C)
(NASA-CR-187941; NAS 1.26:187941; UMIACS-TR-91-23; CS-TR-2606) Avail: NTIS HC/MF A03 CSCL 09B

Reuse of products, processes, and other knowledge will be the key to enable the software industry to achieve the dramatic improvement in productivity and quality required to satisfy the anticipated growing demands. Although experience shows that certain kinds of reuse can be successful, general success has been elusive. A software life-cycle technology which allows comprehensive reuse of all kinds of software-related experience could provide the means to achieving the desired order-of-magnitude improvements. A comprehensive framework of models, model-based characterization schemes, and support mechanisms for better understanding, evaluating, planning, and supporting all aspects of reuse are introduced. Author

N91-22722*# Cornell Univ., Ithaca, NY. Dept. of Computer Science.
PROGRAMMING WITH PROCESS GROUPS: GROUP AND MULTICAST SEMANTICS
Kenneth P. Birman, Robert Cooper, and Barry Gleeson (Unisys Corp., San Jose, CA.) Jan. 1991 25 p
(Grant NAG2-593)
(NASA-CR-187975; NAS 1.26:187975; TR-91-1185) Avail: NTIS HC/MF A03 CSCL 09B

Process groups are a natural tool for distributed programming and are increasingly important in distributed computing environments. Discussed here is a new architecture that arose from an effort to simplify Isis process group semantics. The findings include a refined notion of how the clients of a group should be treated, what the properties of a multicast primitive should be when systems contain large numbers of overlapping groups, and a new construct called the causality domain. A system based on this architecture is now being implemented in collaboration with the Chorus and Mach projects. Author

N91-22723*# Auburn Univ., AL. Dept. of Computer Science and Engineering.
GRASP/ADA: GRAPHICAL REPRESENTATIONS OF ALGORITHMS, STRUCTURES, AND PROCESSES FOR ADA. THE DEVELOPMENT OF A PROGRAM ANALYSIS ENVIRONMENT FOR ADA: REVERSE ENGINEERING TOOLS FOR ADA, TASK 2, PHASE 3 Semiannual Report, 1 Jun. - 31 Nov. 1990
James H. Cross, II Feb. 1991 108 p
(Contract NCC8-14)
(NASA-CR-187982; NAS 1.26:187982) Avail: NTIS HC/MF A06 CSCL 09B

The main objective is the investigation, formulation, and generation of graphical representations of algorithms, structures, and processes for Ada (GRASP/Ada). The presented task, in which various graphical representations that can be extracted or generated from source code are described and categorized, is focused on reverse engineering. The following subject areas are covered: the system model; control structure diagram generator; object oriented design diagram generator; user interface; and the GRASP library. Author

N91-22724*# Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
RICIS SOFTWARE ENGINEERING 90 SYMPOSIUM: AEROSPACE APPLICATIONS AND RESEARCH DIRECTIONS PROCEEDINGS
1990 70 p Symposium held in Houston, TX, 7-8 Nov. 1990
(Contract NCC9-16)
(NASA-CR-187993; NAS 1.26:187993) Avail: NTIS HC/MF A04 CSCL 09B

Papers presented at RICIS Software Engineering Symposium are compiled. The following subject areas are covered: synthesis - integrating product and process; Serpent - a user interface management system; prototyping distributed simulation networks; and software reuse. For individual titles, see N91-22725 through N91-22727.

N91-22725*# Software Productivity Consortium, Herndon, VA.
SYNTHESIS: INTERTWINING PRODUCT AND PROCESS
David M. Weiss *In* Houston Univ., RICIS Software Engineering 90 Symposium: Aerospace Applications and Research Directions Proceedings 1990 19 p (For primary document see N91-22724 14-61)
Avail: NTIS HC/MF A04 CSCL 09B

Synthesis is a proposed systematic process for rapidly creating different members of a program family. Family members are described by variations in their requirements. Requirements variations are mapped to variations on a standard design to generate production quality code and documentation. The approach is made feasible by using principles underlying design for change. Synthesis incorporates ideas from rapid prototyping, application generators, and domain analysis. The goals of Synthesis and the Synthesis process are discussed. The technology needed and the feasibility of the approach are also briefly discussed. The status of current efforts to implement Synthesis methodologies is presented. Author

N91-22726*# Carnegie-Mellon Univ., Pittsburgh, PA.
SOFTWARE ENGINEERING ACTIVITIES AT SEI (SOFTWARE ENGINEERING INSTITUTE)
Clyde Chittister *In* Houston Univ., RICIS Software Engineering 90 Symposium: Aerospace Applications and Research Directions Proceedings 1990 12 p (For primary document see N91-22724 14-61)
Avail: NTIS HC/MF A04 CSCL 09B

Prototyping was shown to ease system specification and implementation, especially in the area of user interfaces. Other prototyping approaches do not allow for the evolution of the prototype into a production system or support maintenance after the system is fielded. A set of goals is presented for a modern user interface environment and Serpent, a prototype implementation that achieves these goals, is described. Author

N91-22727*# Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.
PROTOTYPING DISTRIBUTED SIMULATION NETWORKS
Dennis L. Doubleday *In* Houston Univ., RICIS Software Engineering 90 Symposium: Aerospace Applications and Research Directions Proceedings 1990 11 p (For primary document see N91-22724 14-61)
Avail: NTIS HC/MF A04 CSCL 09B

Durra is a declarative language designed to support application-level programming. The use of Durra is illustrated to describe a simple distributed application: a simulation of a collection of networked vehicle simulators. It is shown how the language is used to describe the application, its components and structure, and how the runtime executive provides for the execution of the application. Author

N91-22728*# Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
RICIS SOFTWARE ENGINEERING 90 SYMPOSIUM: AEROSPACE APPLICATIONS AND RESEARCH DIRECTIONS PROCEEDINGS APPENDICES
1990 136 p Symposium held in Houston, TX, 7-8 Nov. 1990 (Contract NCC9-16)
(NASA-CR-187994; NAS 1.26:187994) Avail: NTIS HC/MF A07 CSCL 09B

Papers presented at RICIS Software Engineering Symposium are compiled. The following subject areas are covered: flight critical software; management of real-time Ada; software reuse; megaprogramming software; Ada net; POSIX and Ada integration in the Space Station Freedom Program; and assessment of formal methods for trustworthy computer systems. For individual titles, see N91-22729 through N91-22730.

N91-22729*# Boeing Co., Seattle, WA.
SOFTWARE: WHERE WE ARE AND WHAT IS REQUIRED IN THE FUTURE
Jerry Cohen *In* Houston Univ., RICIS Software Engineering 90 Symposium: Aerospace Applications and Research Directions Proceedings Appendices 1990 27 p (For primary document see N91-22728 14-61)
Avail: NTIS HC/MF A07 CSCL 09B

The current status and future direction of flight critical software are presented in the form of view-graphs. The following subject areas are covered: the programmers environment; Saab Grippen Flight test program; present day tools; analysis tools (reverse engineering); automatic code generators; and future plans. Author

N91-22730*# IBM Federal Systems Div., Owego, NY.
A CONCEPTUAL MODEL FOR MEGAPROGRAMMING
Will Tracz *In* Houston Univ., RICIS Software Engineering 90 Symposium: Aerospace Applications and Research Directions Proceedings Appendices 1990 12 p (For primary document see N91-22728 14-61)
Avail: NTIS HC/MF A07 CSCL 09B

Megaprogramming is component-based software engineering and life-cycle management. Magaprogramming and its relationship to other research initiatives (common prototyping system/common prototyping language, domain specific software architectures, and software understanding) are analyzed. The desirable attributes of megaprogramming software components are identified and a software development model and resulting prototype megaprogramming system (library interconnection language extended by annotated Ada) are described. Author

N91-22731*# Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
PORTABLE COMMON EXECUTION ENVIRONMENT (PCEE) PROJECT REVIEW: PEER REVIEW Final Report
C. Douglass Locke (International Business Machines Corp., Bethesda, MD.) 8 Mar. 1991 23 p
(Contract NCC9-16)
(NASA-CR-188016; NAS 1.26:188016) Avail: NTIS HC/MF A03 CSCL 09B

The purpose of the review was to conduct an independent, in-depth analysis of the PCEE project and to provide the results of said review. The review team was tasked with evaluating the potential contribution of the PCEE project to the improvement of the life cycle support of mission and safety critical (MASC) computing components for large, complex, non-stop, distributed systems similar to those planned for such NASA programs as the space station, lunar outpost, and manned missions to Mars. Some conclusions of the review team are as follow: The PCEE project was given high marks for its breath of vision on the overall problem with MASC software; Correlated with the sweeping vision, the Review Team is very skeptical that any research project can successfully attack such a broad range of problems; and several recommendations are made such as to identify the components of the broad solution envisioned, prioritizing them with respect to their impact and the likely ability of the PCEE or others to attack them successfully, and to rewrite its Concept Document differentiating the problem description, objectives, approach, and results so that the project vision becomes assessible to others. Author

N91-22732# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
DEVELOPMENT OF AN INTERACTIVE DATA BASE WITH ELEMENTS GENERATED BY SWEEPING FOR A CAD SYSTEM M.S. Thesis [DESENVOLVIMENTO DE UM BANCO DE DADOS INTERATIVO COM ELEMENTOS GERADOS POR VARREDURA PARA UM SISTEMA CAD]
Andres Fernando Pare Horna Sep. 1990 393 p In PORTUGESE; ENGLISH summary
(INPE-5118-TDL/420) Avail: NTIS HC/MF A17

The development of an interactive software that implements a geometrical modeler with hierarchical features for the construction of solids in a computer aided design system is discussed. The solids are built following a hierarchical binary tree structure whose lowest level elements are used for generating solids through a technique known as rotational or translational 'sweeping', either around a revolution axis or along a straight line, respectively. The swept generated solids are then composed with each other, using Boolean operations, in order to obtain the final desired form. First, the kind of data base structure used is justified and its operation described; then a geometric modeling theoretical basis is presented as well as the main solid representation schemes. Finally, with the purpose of increasing the feasibility of the transportability of the geometric modeler to other systems, using standard graphic packages, a comparison with the most used graphic standards is made. Author

N91-22733# Northwestern Univ., Evanston, IL. Dept. of Civil Engineering.
CONTACT-IMPACT ALGORITHMS FOR PENETRATION STUDIES Final Report, Mar. 1987 - Aug. 1990
Ted Belytschko, Wing K. Liu, and Mark ONeal 15 Nov. 1990 21 p
(Contract DAAL03-87-K-0035)
(AD-A231049; ARO-23852.11-MA) Avail: NTIS HC/MF A03 CSCL 12/5

Contact impact algorithms, which are sometimes called slideline algorithms, are a computationally time-consuming part of many explicit simulations of nonlinear problems. One of the reasons for their computational expense is that slideline algorithms are complex with many branches, so they are not amenable to vectorization, which is essential for speed on supercomputers. The pinball algorithm is a simplified slideline algorithm which is readily vectorized. Its major idea is to embed pinballs in surface elements and to enforce the impenetrability condition only to pinballs. The algorithm has been implemented in the WHAMS-3D code. Examples of solutions and running times are given. GRA

N91-22734# Dayton Univ., OH.
CREW CHIEF CAD SYSTEM INTERFACE GUIDE (VERSION 2 - SI) Technical Report, May 1988 - Nov. 1989
P. J. Krauskopf, J. W. Quinn, M. W. Jones, and W. J. Stump Mar. 1990 190 p
(Contract F33615-84-C-0519)
(AD-A231433; UDR-TR-90-15; AAMRL-TR-90-015) Avail: NTIS HC/MF A09 CSCL 12/5

This report describes the procedures to interface the CREW CHIEF programs with a user's computer aided design system through the Common Users Interface (CUI). The CUI was developed as the vehicle to pass information between the CREW CHIEF core programs and data bases and the user's CAD system. A set of interface subroutines pass input, output, and diagnostic parameters, in that order. Each passed variable is named according to FORTRAN variable type defaults, with identical parameter entities always represented by identical parameter names. CADAM and Computervision CV4001 and CADDStation are commercial CAD systems, used during the development of CREW CHIEF and CREW CHIEF interfaces. Their use, and reference to them, does not constitute an endorsement by the United States Air Force or the University of Dayton. GRA

N91-22735# Maryland Univ., College Park. Inst. for Advanced Computer Studies.
PARALLEL IMPLEMENTATION OF THE hp-VERSION OF THE FINITE ELEMENT METHOD ON A SHARED-MEMORY ARCHITECTURE Final Report
I. Babuska, H. C. Elman, and K. Markley Nov. 1990 30 p
(Contract N00014-90-J-1030; NSF CCR-88-20279; NSF ASC-89-58544; NSF DMS-86-07478)
(AD-A231506; UMIACS-TR-90-139; CS-TR-2562) Avail: NTIS HC/MF A03 CSCL 12/5

We study the costs incurred by an implementation of the hp-version of the finite element for solving two-dimensional elliptic partial differential equations on a shared-memory parallel computer. For a collection of benchmark problems, we systematically examine the costs in central processing unit time of various individual subtasks performed by the finite element solver, including construction of local stiffness matrices, elimination of unknowns associated with element interiors, and global solution on element interfaces by a preconditioned conjugate gradient method. Our general observations are that the costs of the naturally parallel computations associated with local elements are significantly higher than any global computations, so that the latter do not represent a significant bottleneck to parallel efficiency. However, memory conflicts place some limitations on the sizes or number of local problems that can be handled efficiently in parallel. GRA

N91-22736# Army Lab. Command, Fort Monmouth, NJ. Electronics Technology and Devices Lab.
USER'S GUIDE FOR TEST PATTERN TOOLS FOR THE PERSONAL COMPUTER Technical Report, Jul. 1987 - Jul. 1990
John M. Erickson Dec. 1990 23 p
(AD-A231517; SLCET-TR-90-10) Avail: NTIS HC/MF A03 CSCL 12/5

The test pattern tools include: vertical sequence search, overwrite up to 10 unique vertical sequences simultaneously in any one column or column group, view-point save a specified block within the pattern, 2-3-4 bit hexadecimal to binary number conversion (and vice versa), 32-bit binary sequence generation, and waveform display using a pattern window of up to 73 columns by 400 lines. There are more than 30 editing and utility routines. Pattern files as large as 1050 columns by more than 10 x 10(exp 6) lines can be analyzed. Pattern sequences of up to 1050 characters can be edited in either the horizontal or vertical direction. The pattern tools require the IBM or IBM compatible XT, AT or PS/2, DOS 2.1 or later, a hard disk, and approximately 400 K of memory for the main program and support files. GRA

N91-22737# Joint Data Systems Support Center, Washington, DC.
SOFTWARE REQUIREMENTS SPECIFICATION FOR THE MAPPING AND GRAPHIC INFORMATION CAPABILITY (MAGIC). VOLUME 1: HUMAN INTERFACE CSCI
David W. Hall and D. R. Cozad 1 Dec. 1990 53 p
(AD-A231752; DCA/JDSSC-SRS-1-90-Vol-1) Avail: NTIS HC/MF A04 CSCL 12/5

This Software Requirements Specification (SRS) specifies the engineering and qualification requirements for the Human Interface Computer Software Configuration Item (CSCI) of the Mapping and Graphic Information Capability (MAGIC). Furthermore, this specification will be used as the basis for the design and formal testing of that CSCI. The SRS is divided into 3 major sections. These sections cover Engineering Requirements (Section 3), Qualification Requirements (Section 4), and Preparation for Delivery (Section 5), the Human Interface Computer Software Configuration Item functions as the logical hub of all MAGIC processing activities and presents a user/friendly graphical user interface (GUI) to the user that is compliant with Open Software Foundation (OSF)/Motif. The user may choose menu selections with either keystrokes or mouse clicks and dialog boxes are provided for those instances when the user is required to provide additional information before MAGIC can continue processing. When a user initiates a MAGIC session, the program menus are presented to the user, and control of program actions begin in this CSCI. As users navigate through the menu system to an activity they want to perform, control is eventually passed to the appropriate functional CSCI (or Commercial Off-The-Shelf (COTS) package), such as Data Management or Business Graphics, to perform the desired activity. The Human Interface CSCI also provides context sensitive help that is compliant with Motif applications. GRA

N91-22738# Joint Data Systems Support Center, Washington, DC.
SOFTWARE REQUIREMENTS SPECIFICATION FOR THE MAPPING AND GRAPHIC INFORMATION CAPABILITY (MAGIC). VOLUME 2: DATA MANAGEMENT CSCI
David W. Hall and D. R. Cozad 1 Dec. 1990 47 p
(AD-A231753; DCA/JDSSC-SRS-1-90-Vol-2) Avail: NTIS HC/MF A03 CSCL 12/5

The Data Management Computer Software Configuration Item (CSCI) enables the user to access data from user databases located on either the WWMCCS host or the WWMCCS Workstation (WWS). The WWS databases may be Oracle relational database tables to which the user has access or flat American Standard Code for Information Interchange (ASCII) files. Data in the databases is selected by a user according to a qualification criterion; the resulting data subset can then be manipulated and presented as user-formatted reports, statistical graphs, and geographic displays. The SRS specifies the requirements allocated to the Data Management CSCI and enables the Government to assess whether or not the completed CSCI complies with those requirements. Upon Government approval and authentication, the SRS becomes the Allocated Baseline for the CSCI and is used by the contractor as the basis for development and formal testing of the CSCI. GRA

N91-22739# Joint Data Systems Support Center, Washington, DC.
SOFTWARE REQUIREMENTS SPECIFICATION FOR THE MAPPING AND GRAPHIC INFORMATION CAPABILITY (MAGIC). VOLUME 3: BUSINESS GRAPHICS CSCI
David W. Hall and D. R. Cozad 1 Dec. 1990 48 p
(AD-A231754; DCA/JDSSC-SRS-1-90-Vol-3) Avail: NTIS HC/MF A03 CSCL 12/5

The Business Graphics Computer Software Configuration Item (CSCI) enables the MAGIC user to create and display reports. Each report consists of data selected form a previously identified MAGIC internal format subset of a database. The CSCI gives the user the flexibility to display a report in a form most suited to the user's needs, varying from simple formatted reports to line graphs and pie charts. The Wingz Commercial Off-The-Shelf (COTS)

package has been used to provide the user with two levels of support: an assisted mode, which helps the user in constructing reports and graphs, and an unassisted mode in which the user is simply placed within the Wingz product and is expected to know what is needed to use that package effectively. The SRS specifies the requirements allocated to the Business Graphics CSCI and enables the Government to assess whether or not the completed CSCI complies with those requirements. Upon Government approval and authentication, the SRS becomes the Allocated Baseline for the CSCI and is used by the contractor as the basis for development and formal testing of the CSCI. GRA

N91-22740# Joint Data Systems Support Center, Washington, DC.
SOFTWARE REQUIREMENTS SPECIFICATION FOR THE MAPPING AND GRAPHIC INFORMATION CAPABILITY (MAGIC). VOLUME 7: INTERNAL PROCESSING CSCI
David W. Hall and D. R. Cozad 1 Dec. 1990 50 p
(AD-A231755; DCA/JDSSC-SRS-1-90-Vol-7) Avail: NTIS HC/MF A03 CSCL 12/5

The Internal Processing Computer Software Configuration Item (CSCI) provides capabilities that are hardware-dependent or required by more than one CSCI. A multitude of services unseen by the user but critical to MAGIC functionality are provided. As its name implies, a variety of low-level services that tie the various functional CSCI's together are provided. They are as follows: (1) MAGIC environment initialization and cleanup; (2) File input/output (I/O functions as open, close, read, and write operations; (3) Functions useful to a number of MAGIC's CSCIs, such as string utilities, and pathname processing; and (4) Communications between the Unix workstation and the WWMCCS host platform. GRA

N91-22741# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
INCREASING THE READABILITY AND COMPREHENSIBILITY OF PROGRAMS M.S. Thesis
Thomas M. Schorsch 1990 64 p
(AD-A231805; AFIT/CI/CIA-90-141) Avail: NTIS HC/MF A04 CSCL 12/5

Source code must be readable and understandable in order to be debugged, used, and maintained efficiently and effectively. Creating programs that are easily read and understood is important, but not as simple as one might think. The ways are surveyed in which programming style, programming language design and program presentation influence a person's ability to read and understand program text. It is concerned with solving small scale problems associated with individual functions or files and not with problems that pertain exclusively to large software systems. The programming style chapter examines the changes a programmer may make to source code without modifying the content or meaning of the code. Two of the main sections cover code reformatting and identifier naming conventions. The chapter on language design discusses the selection of basic tokens (symbols and keywords) and the structure of language statements. This chapter also categorizes the subtle errors that occur when the meanings of a code segment when read and when executed are not the same. The program presentation chapter presents methods for enhancing completed source code making it easier to read and its true meaning easier to discern. Restructuring/transforming the code, graphic design principles, and introducing supplemental information are some of the main sections. Knuth's literate programming paradigm is examined in this chapter as well. One of the underlying themes is that an automated proofreader program could greatly aid programmers to create readable, unstandable programs. GRA

N91-22742# Naval Ocean Systems Center, San Diego, CA.
ADAPTIVE MIXTURE APPROACH TO PATTERN RECOGNITION Final Report, Oct. 1989 - Sep. 1990
C. E. Priebe and D. J. Marchette Nov. 1990 19 p
(AD-A231831; NOSC/TD-1946) Avail: NTIS HC/MF A03 CSCL 12/9

A large number of pattern recognition tasks require the ability to recognize patterns within data when the character of the patterns may change with time. Examples of such tasks are remote sensing, autonomous control, and automatic target recognition in a changing environment. These tasks have a common requirements: the need to recognize new entities as they enter the environment. A pattern recognition system must be able to recognize and develop a representation of a new pattern in the environment as well as to change its representation of the statistics of the pattern dynamically. The adaptive mixtures approach presented here uses density estimation to develop decision functions for supervised and unsupervised learning. Much work in performing density estimation in supervised situations has been done. For the most part, this research has centered on approaches that use a great deal of a priori information about the structure of the data. In this work, we apply statistical pattern recognition concepts to the problem of recursive nonparametric pattern recognition in dynamic environments. GRA

N91-22743# Purdue Univ., West Lafayette, IN. School of Electrical Engineering.
MODELING, ESTIMATION, AND PATTERN ANALYSIS OF RANDOM TEXTURE ON 3-D SURFACES Interim Technical Report, Jan. 1989 - Dec. 1990
Yoonsik Choe and R. L. Kashyap 1 Dec. 1990 179 p
(Contract DAAL03-89-K-0032)
(AD-A231849; TR-EE-91-4; ARO-26656.6-MA) Avail: NTIS HC/MF A09 CSCL 12/9

To recover three-dimensional structure from a shaded and textural surface image involving textures, neither the Shape-from-shading nor the Shape-from-texture analysis is enough, because both radiance and texture information coexist within the scene surface. A new 3-D texture mathematical model is developed by considering the scene image as the superposition of the smooth shaded image and a random texture image. To describe the random part, the orthographical projection is adapted to take care of the non-isotropic distribution function of the intensity due to the slant and tilt of a 3-D texture surface, and the Fractional Differencing Period (FDP) model is choosen to describe the random texture, because this model is able to simultaneously represent the courseness and the pattern of the 3-D texture surface, and enough flexible to synthesize both long-term and short-term correlation structures of random texture. For estimating the parameters, a hybrid method which uses both the least square and the maximum likelihood estimates is applied and the estimation of parameters and the synthesis are done in frequency domain. Fractal scaling parameter plays a major role for classifying and/or segmenting the different texture patterns tilted and slanted due to the 3-dimensional rotation, because of its rotational and scaling invariant properties. A new classification method and a segmentation scheme fo rthe 3-D rotated texture patterns is developed. GRA

N91-22744# Naval Postgraduate School, Monterey, CA.
SAFETY ANALYSIS OF HETEROGENEOUS-MULTIPROCESSOR CONTROL SYSTEM SOFTWARE M.S. Thesis
Janet A. Gill Dec. 1990 63 p
(AD-A231859) Avail: NTIS HC/MF A04 CSCL 12/5

Fault trees and Petri nets are two widely accepted graphical tools used in the safety analysis of software. Because some software is life and property critical, thorough analysis techniques are essential. Independently Petri nets and fault trees serve limited evaluation purposes. This thesis presents a technique that converts and links Petri nets to fault trees and fault trees to Petri nets. It enjoys the combinational benefits of both analysis tools. Software Fault Tree Analysis and timed Petri nets facilitate software safety analysis in heterogeneous multiprocessor control systems. Analysis use a Petri net to graphically organize the selected software. A fault tree supports a hazardous condition with subsequent leaf node paths that lead to the hazard. Through the combination of Petri nets and fault trees, an analyst can determine a software fault if he can reach an undesired Petri net state, comparable

with the fault tree root fault, from an initial marking. All transitions leading to the undesired state from the initial marking must be enabled and the states must be marked that represent the leaf nodes of the fault tree path. It is not the intention of this thesis to suggest that an analyst be replaced by an automated tool. There must be analyst interaction focusing the analyst's insight and experience on the hazards of a system. This method is proposed only as a tool for evaluation during the overall safety analysis.
GRA

N91-22745# Naval Postgraduate School, Monterey, CA.
AN EMPIRICAL STUDY OF THE FAULT-PREDICTIVE ABILITY OF SOFTWARE CONTROL-STRUCTURE METRICS M.S. Thesis
Alberto Teixeira BigottededeAlmeida Jun. 1990 81 p
(AD-A231860) Avail: NTIS HC/MF A05 CSCL 12/5

The increasing cost and complexity of software in recent years is causing growing interest in the development of measurement technology to evaluate, predict and compare software complexity. Metrics can be used throughout all the development cycle providing valuable information to the software developers in order to enhance the final products. The goal of this thesis is to verify empirically the fault-predictive ability of some software complexity metrics and specifically their usefulness during the testing phase. A set of eight programs, varying in length from 1,186 to 2,489 lines of Pascal code with 157 faults identified with specific modules, provided the data for this study. The results of the analysis of the programs using four metrics, cyclomatic complexity, bandwidth, nested complexity and the number of statements, show that control-structure metrics can be effectively used to detect the more fault-prone modules. The nested complexity of the modules seems to be some relation with the number of faults caused by wrong use of variables and overrestrictive input checks. These observations can be particularly useful during the testing phase because testers can use control-structure metrics to predict not only the modules that may cause more problems but also the more frequent types of faults and use the metrics to guide the choice of testing techniques.
GRA

N91-22746# Joint Data Systems Support Center, Washington, DC.
OPERATIONAL CONCEPT DOCUMENT FOR THE MAPPING AND GRAPHIC INFORMATION CAPABILITY (MAGIC)
David W. Hall 15 Jan. 1991 35 p
(AD-A231882; DCA/JDSSC-TM-406-9) Avail: NTIS HC/MF A03 CSCL 12/7

This Operational Concept Document (OCD) describes the mission of MAGIC and its operational and support environments. It also describes the functions and characteristics of the computer system within the overall system. The MAGIC effort has evolved from and will build upon the modernization of the WWMCCS standard host-based Graphic Information Presentation System (GIPSY) and the Z-248 PC-based modernized GIPSYmate system. Designed and developed to meet the needs of a new generation of Worldwide Military Command and Control System (WWMCCS) users, MAGIC will be fielded as a resident system on the WWMCCS Workstation (WWS) and will present a menu-based graphical user interface (GUI) to the user that integrates (as transparently as feasible) the Commercial Off-the-Shelf (COTS) packages also resident on that platform. Processing facilities appropriate to both sophisticated and novice users will be supported as well as the ability to access the full range of database types found on the WWMCCS host (H6000). Functionally, the MAGIC user will have the capability to perform data retrieval and manipulation operations, business graphics displays, geographic and geodetic mapping displays, slide show generation, and graphic editing operations.
GRA

N91-22747# Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
THE DESIGN AND ANALYSIS OF EFFICIENT LEARNING ALGORITHMS Ph.D. Thesis
Robert E. Schapire Jan. 1991 190 p Sponsored by DARPA, Arlington, VA
(AD-A231888; MIT/LCS/TR-493) Avail: NTIS HC/MF A09 CSCL 12/9

This thesis explores various theoretical aspects of machine learning with particular emphasis on techniques for designing and analyzing computationally efficient learning algorithms. Many of the results in this thesis are concerned with a model of concept learning proposed by Valiant. The thesis begins in Chapter 2 with a proof that any 'weak' learning algorithm in this model that performs slightly better than random guessing can be converted into one whose error can be made arbitrarily small. Several interesting consequences of this result are also described. Chapter 3 next explores in detail a simple but powerful technique for discovering the structure of an unknown read-once formula from random examples. An especially nice feature of this technique is its powerful resistance to noise. Chapter 4 considers a realistic extension of the PAC model to concepts that may exhibit uncertain or probabilistic behavior. A range of techniques are explored for designing efficient algorithms for learning such probabilistic concepts. In the last chapter, we present new algorithms for inferring an unknown finite-state automation from its input-output behavior. This problem is motivated by that faced by a robot in unfamiliar surroundings who must, through experimentation, discover the structure of its environment.
GRA

N91-22748# Stanford Univ., CA. Systems Optimization Lab.
AN ADAPTIVE PRIMAL-DUAL METHOD FOR LINEAR PROGRAMMING
Florian Jarre and Michael A. Saunders Jan. 1991 13 p
(Contract N00014-90-J-1242; NSF DDM-87-15153)
(AD-A231903; SU-SOL-91-1) Avail: NTIS HC/MF A03 CSCL 12/4

The short-step interior-point methods that allow nice polynomial-time proofs of convergence for linear programming turn out to be much too slow for practical algorithms. Thus a number of long-step methods have been analyzed to date, most of which are aimed at proving the correctness of existing numerical implementations. In Section 3.1, however, a worst-case example is presented in which the iterates x, y, z are not able to follow a long step in the reduction of the complementarity parameter microns. The possibility of such worst cases is responsible for the weak proofs of convergence for long-step methods. These proofs not only fail to explain the fast convergence of the implementations that has been observed for all numerical examples, but also exhibit a wore theoretical complexity than even the short-step methods. The adaptive method presented here is intended to close the gap between theoretical and practical complexity.
GRA

N91-22749# Atmospheric and Environmental Research, Inc., Cambridge, MA.
PATH CHARACTERIZATION ALGORITHMS FOR FASCODE Final Report, 17 Jul. 1987 - 17 Jan. 1990
R. G. Isaacs, S. A. Clough, S. D. Worsham, J. L. Moncet, and B. L. Linder 14 Mar. 1990 203 p
(Contract F19628-89-C-0129)
(AD-A231914; GL-TR-90-0080) Avail: NTIS HC/MF A10 CSCL 12/5

The results of a study undertaken at AER to identify and implement a state of the art nonlinear retrieval approach to characterize line of sight variability of atmospheric thermal and constituent environments are described. This path characterization capability was designed to interface with the existing Geophysics Laboratory (GL) line-by-line radiance/transmittance code, FASCODE. Accomplishments of the study include: (1) a review of the relevant literature concerning potential path characterization retrieval algorithms, selection of a physical least squares (PLS) nonlinear retrieval approach for implementation based on criteria which includes flexibility within the context of FASCODE, and a certain degree of robustness in application; (2) development of a stand alone, preprocessing screening procedure to identify potential channels for path characterization based on user requirements; (3) formulation and implementation of the path characterization retrieval algorithm including suitable interfaces with FASCODE; (4)

inclusion of a comprehensive error analysis capability as an integral part of the retrieval procedure; (5) demonstration of the approach for the retrieval of temperature, water vapor, and ozone; and (6) comprehensive documentation of the path characterization code implementations. Author

N91-22750# Naval Postgraduate School, Monterey, CA.
VIEWER: A USER INTERFACE FOR FAILURE REGION ANALYSIS M.S. Thesis
Vicki S. Abel and Medio Monti Dec. 1990 271 p
(AD-A231955) Avail: NTIS HC/MF A12 CSCL 12/5

Two issues gaining interest in the computer community are the development of software testing tools and the increase of graphical user interfaces in all types of software. VIEWER is a program that provides support to a set of tools that work in an integrated fashion to analyze Pascal programs to determine the failure regions associated with identified faults in the program. It is a graphical user interface that facilitates the process of analyzing the program. It provides automated coordination between the tools and as such maintains a certain level of abstraction for the analyst. It allows for rapid and customized improvements in the automation of the analysis process. The thesis discusses the background involved in testing tools, user interfaces, and the combination of the two into a useful tool. An implemented prototype is discussed and an example of failure region analysis performed with the graphical user interface is included. GRA

N91-22751# Unixpros, Inc., Colts Neck, NY.
EVALUATION OF THE ACEC BENCHMARK SUITE FOR REAL-TIME APPLICATIONS Final Report
Arvind Goel 23 Jul. 1990 82 p
(Contract DAAB07-87-D-B008)
(AD-A231968) Avail: NTIS HC/MF A05 CSCL 12/5

This technical report has been developed by the Center for Software Engineering, U.S. Army CECOM to evaluate the Ada Compiler Evaluation Capability (ACEC) Version 1.0 benchmark suite for measuring the performance of Ada compilers meant for programming real time systems. The ACEC benchmarks have been analyzed extensively with respect to their measuring of Ada real time features such as tasking, memory management, input/output, scheduling and delay statement, Chapter 13 feature, pragmas, interrupt handling, subprogram overhead, numeric computations etc. For each of the features that have been analyzed, additional benchmarks have been proposed. Finally, the ACEC benchmarks that measure Ada features important for programming real-time systems have been run on two Ada compilers, namely the HP Ada compiler self-hosted on HP 900/350 and the Verdix Ada compiler hosted on the Sun 3/60 and targeted to a Motorola 68020 bare machine and their results listed. GRA

N91-22752*# Cornell Univ., Ithaca, NY. Dept. of Computer Science.
MASKING FAILURES OF MULTIDIMENSIONAL SENSORS (EXTENDED ABSTRACT)
Paul Chew and Keith Marzullo 6 Dec. 1990 11 p
(Contracts NAG2-593; N00014-88-K-0591; N00014-89-J-1946; N00140-87-C-8904; NSF IRI-90-06137)
(NASA-CR-188120; NAS 1.26:188120) Avail: NTIS HC/MF A03 CSCL 09B

When a computer monitors a physical process, the computer uses sensors to determine the values of the physical variables that represent the state of the process. A sensor can sometimes fail, however, and in the worst case report a value completely unrelated to the true physical value. The work described is motivated by a methodology for transforming a process control program that can not tolerate sensor failure into one that can. In this methodology, a reliable abstract sensor is created by combining information from several real sensors that measure the same physical value. To be useful, an abstract sensor must deliver reasonably accurate information at reasonable computational cost. Sensors are considered that deliver multidimensional values (e.g., location or velocity in three dimensions, or both temperature and pressure). Geometric techniques are used to derive upper bounds on abstract sensor accuracy and to develop efficient algorithms for implementing abstract sensors. GRA

N91-22753# Norwegian Defence Research Establishment, Kjeller.
SYSTEM FOR GENERATION OF SYNTHETIC IMAGES (SYBIL)
Einar Oestevold, Tor Hoeimyr, and Geir Atle Storhaug 12 Dec. 1990 51 p In NORWEGIAN; ENGLISH summary
(FFI-90/4002; ETN-91-99121; ISSN-0802-2437) Avail: NTIS HC/MF A04

From a comittment to produce synthetic infrared images of land and sea targets, the development of a system for the generation of synthetic images (Norwegian acronym SYBIL) was defined. A system for production of synthetic images was developed which will typically be used for simulating various kinds of camouflage and for development and testing of algorithms for target acquisition and tracking. Images of objects can be put into real images of background scenes, and both objects and background can be manipulated. Models are used to simulate atmosphere and various camouflage efforts (smoke, net etc.). The system also includes tools for future extensions. A model for animation (for image sequences) and a thermal radiation model for the intensity (grey level) manipulations are under development and will be implemented. ESA

N91-22754# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
A PACKAGE TO EVALUATE ONE-LOOP FEYNMAN DIAGRAMS
G. J. vanOldenborgh Sep. 1990 22 p
(NIKHEF-H/90-15; ETN-91-99129) Avail: NTIS HC/MF A03

A short description and a user's guide of the FORMF package are given. This package contains routines to evaluate numerically the scalar one loop integrals occurring in the evaluation in one loop Feynman diagrams. The algorithms chosen are numerically stable over most of parameter space. The problems which might be encountered when installing FORMF on a computer system are discussed. The initialization of the routines, which has to be done by the user in the program which uses the FORMF routines, is outlined. The use of the error reporting facilities, which also need some assistance from the user is considered. A list of available routines for the scalar n-point functions and determinants is given, listing parameters, loss of precision, and comments. Some sample input and output is given. ESA

N91-22755# Universiteit Twente, Enschede (Netherlands). Dept. of Computer Science.
CROSS-FERTILIZATION OF EARLEY AND TOMITA
Klaas Sikkel Nov. 1990 44 p
(MEMO-INF-90-69; ISSN-0923-1714; ETN-91-99138) Avail: NTIS HC/MF A03

Earley's and Tomita's algorithms are superficially rather different. Their underlying structure, however, is remarkably similar. For a closer inspection of differences and similarities, variants of Earley and Tomita are defined which produce (almost) indistinguishable results: a parse stack annotated with recognized items. Tomita's algorithm is more sensitive to the complexity of this spark stack. It will be better than Earley's algorithm, provided that the grammar is not too complicated (i.e., not densely ambiguous). Exploiting the uncovered similarity between Earley and Tomita, means that extensions and variations that were meant for one species can be applied to the other species as well. As a particularly promising example of such offspring, the Tomita counterpart of a parallel bottom up Earley variant, in which each of n processors computes a row of the upper triangular Earley recognition matrix are defined. This parallel bottom to Tomita algorithm should be rather efficient for natural language applications. It will be the subject of further empirical research. ESA

N91-22756# Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
NEW CONSTRUCTS FOR THE DESCRIPTION OF COMBINATORIAL OPTIMIZATION IN ALGEBRAIC MODELING LANGUAGES
J. J. Bisschop and R. Fourer (Northwestern Univ., Evanston, IL.) Nov. 1990 24 p Sponsored by Koninklijke/Shell-Lab.
(Memo-901; ISSN-0169-2690; ETN-91-99139) Avail: NTIS HC/MF A03

Through a series of examples, it is shown how an algebraic modeling language designed for linear and nonlinear programming might be extended to help with a greater variety of combinatorial (or discrete) optimization problems. In particular, problems for which the optimal decision can be regarded as the choice of certain values to variables are considered. Since there is no practicable universal algorithms for these problems, the possibility of employing a general purpose subset enumeration scheme together with problem specific directives to guide an efficient search is explored. ESA

N91-22757# Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
ALGEBRAIC LANGUAGES FOR MATHEMATICAL PROGRAMMING
C. A. C. Kuip Nov. 1990 34 p
(Memo-902; ISSN-0169-2690; ETN-91-99140) Avail: NTIS HC/MF A03

Each of several languages for the formulation of mathematical programming models has its own influence on the human ability to understand, maintain and verify model descriptions. These three criteria form the basis to evaluate these languages and aspects thereof. A classification of languages for linear programming traces a path from algorithm's form via MPS (Mathematical Programming System) format and matrix generator languages to algebraic languages. This classification shows a resemblance to a classification of languages for the formulation of algorithms. In addition to being suited for the formulation of LPs (Linear Programming), algebraic languages are suited for the formulation of NLPs (Nonlinear Programming). The support of index sets, the separation between model and data, and the integration with other software components in the mathematical programming environment are selected fundamental aspects of algebraic languages. Several recent research contributions indicate that there is ample room for both improvements of algebraic languages and new types of languages. ESA

N91-22758# Groningen Rijksuniv. (Netherlands). Dept. of Computing Science.
SMOOTHSORT REVISTED
Coenraad Bron and Wim H. Hesselink Oct. 1990 13 p
(CS-9009; ETN-91-99150) Avail: NTIS HC/MF A03

A renewed analysis of Dijkstra's array sorting algorithm SMOOTHSORT showed that the removal of a complexity improved the performance. The resulting algorithm has a worst case behavior of order N (log N). In the average case, it has more or less the same speed as HEAPSORT. For arrays that are initially almost sorted, it is much faster and can complete with QUICKSORT. The correctness is argued by means of invariants. The performance is measured in terms of comparisons and exchanges, both in the analysis of worst case behavior and in the experimental data. ESA

N91-22759# Groningen Rijksuniv. (Netherlands). Dept. of Computing Science.
SPECIFICATION OF PEEPHOLE OPTIMISATION
Jan H. Jongejan 1990 15 p
(CS-9011; ETN-91-99152) Avail: NTIS HC/MF A03

Peephole optimization performed on Register Transfers (RTs) is studied. During peephole optimization a description of the target machine architecture is used to check if a newly formed RT matches any instruction pattern. All RTs are assumed to be produced by the front end of the compiler match target machine instruction patterns. It is attempted to specify and prove sufficient conditions for keeping the optimized code semantically equivalent to the original code. For this, denotational semantics are extended to be able to use multiple assignment RTs, as some target machines include such instructions. ESA

N91-22760# Technische Univ., Eindhoven (Netherlands).
AN ALGEBRA AND A MESSAGE ORIENTED LANGUAGE FOR A DATA MODEL BASED ON COMPLEX OBJECTS Ph.D. Thesis
Gerard Johan Peter M Houben 1990 333 p Sponsored in part by Netherlands Organization for Applied Scientific Research TNO, Delft
(ETN-91-99163) Avail: NTIS HC/MF A15

The COMO (Complex Object Model) database model, consisting of an object model, and algebra, a message language and a C2 interface, is presented. The object model underlies the COMO approach and is designed to model data with complex structures. The modeling mechanisms include two kinds of entities, complex objects and attribute values, and four kinds of relationships between entities. The tuple, set, attribute, and subset relationships can be used to represent the complex structures composed of complex objects and attribute values. The algebra and message language are two query formalisms for data modeled in the object model. The first is designed in the style of the nested algebra and the second is based on the concept of message passing automata (actors), where every type and object is modeled by an automata. The computation in the second formalism is represented by the communication between the automata. C2 is a graphical interface for the algebra, and offers a graphical approach to the formulation of queries with operations from the algebra. It is specified with the language C1 which is designed for the specification of graphical interfaces for models dealing with data that is complexly structured. ESA

N91-22761# Technische Univ., Eindhoven (Netherlands).
A GENERALISED APPROACH TO GATE ARRAY LAYOUT DESIGN AUTOMATION Ph.D. Thesis
Andre Guillaume Jose Slender 1990 121 p
(ISBN-90-9003442-0; ETN-91-99165) Copyright Avail: NTIS HC/MF A06

A conceptual framework for layout design automation for gate array integrated circuits is presented. The solution gives the user the capability of equipping his design environment with a layout design of an enormous generality. A prototype GAS (Gate Array design System) is implemented to evaluate the concept. The gate arrays are described in a specially developed language (GADTL) and compiled into a common data base. A small selection of coherent placement and routing algorithms exist in the system. Five gate arrays are used for evaluation and experiments reveal that tuning GAS to a new gate array requires one month. The GAS requires 10 Kbytes and 1 Mbyte for gate array and design descriptions. Further improvements in the algorithms which can be achieved by a combined global and detailed routing strategy are required. ESA

N91-22762# Technische Univ., Eindhoven (Netherlands).
MODELING AND CONTROL ALGORITHMS FOR INDUSTRIAL ROBOTS Ph.D. Thesis
Frank Hendrikus Rein Lucassen 1990 184 p In DUTCH; ENGLISH summary
(ISBN-90-9003753-5; ETN-91-99182) Avail: NTIS HC/MF A09

A systematical procedure to build a mathematical model of a rigid robot, based on classical mechanics (Newton/Euler) is described. Starting with the model of a rigid robot two methods are described to extend this model for robots with non rigid links. One method is based on the finite element method, the other on the boundary element method. Both methods seem to have the same numerical properties in robot applications. Two different control concepts are discussed: one based on an exact robot model, the other on model reference adaptive systems. The performance of both algorithms was investigated using simulations. The design of a 3-D measuring system, consisting of several laser

interferometers, and capable of a robot tool center point can be determined with a dynamic accuracy of 10 microns. ESA

N91-22763# Lawrence Livermore National Lab., CA.
USING THE GRAPHICAL KERNEL SYSTEM IN SCIENTIFIC COMPUTING
Kirby W. Fong 25 Jan. 1991 5 p Presented at the NCGA '91 Conference and Exposition, Chicago, 22-25 Apr. 1991
(Contract W-7405-eng-48)
(DE91-010462; UCRL-JC-105515; CONF-9104173-2) Avail: NTIS HC/MF A01

The Graphical Kernel System (GKS) originated as an application interface to two dimensional graphics when it first became an international and U.S. standard in the 1980's. The National Energy Research Supercomputer Center (NERSC) of the Lawrence Livermore National Laboratory provides supercomputing services including graphical output to scientists and engineers performing research for the U.S. Department of Energy's Office of Energy Research. NERSC adopted GKS and has been using it successfully for some of its graphics applications. This article reviews the context in which GKS is effective. DOE

N91-22764# Los Alamos National Lab., NM.
STRAPP USER'S MANUAL
F. M. Guerra Mar. 1991 195 p
(Contract W-7405-eng-36)
(DE91-009846; LA-11966-M) Avail: NTIS HC/MF A09

The Finite Element STRuturcal Analysis Post-Processor (STRAPP) was developed for postprocessing output from finite element programs. Postprocessing capabilities available with this interactive/batch code include contour plotting, transient plots of nodal point parameters, nodal point parameters versus distance plots, and material group summaries. In addition, STRAPP can use the cursor or input data to draw vectors, lines, text, and compute a contour or history plot component at a specified point. The program will output graphics data to a CRT terminal and/or to a CGS-metafile for further post-processing. All input and output data are written onto an ASCII file, and all interactive input is saved in a separate ASCII file. Several examples are used to show the extensive capabilities of the program. DOE

N91-22765# Los Alamos National Lab., NM.
A NEURAL NETWORK HYBRID EXPERT SYSTEM
J. R. Goulding (Portland State Univ., OR.) 1991 7 p Presented at the 5th National Conference on Undergraduate Research, Pasadena, 21-23 Mar. 1991
(Contract W-7405-eng-36)
(DE91-009956; LA-UR-91-903; CONF-9103136-3) Avail: NTIS HC/MF A02

When knowledge-based expert rules, equations, and proprietary languages extend Computer Aided Design and Computer Aided Manufacturing (CAD/CAM) software, previously designed mechanisms can be scaled to satisfy new design requirements in the shortest time. However, embedded design alternatives needed by design engineers during the product conception and rework stages are lacking, and an operator is required who has a thorough understanding of the intended design and the how-to expertise needed to create and optimize the mechanisms. By applying neural network technology to build an expert system, a robust design supervisor system emerged which automated the embedded intellectual operations (e.g. questioning, identifying, selecting, and coordinating the design process) to (1) select the best mechanisms necessary to design a power transmission gearbox from proven solutions; (2) aid the inexperienced operator in developing complex design solutions; and (3) provide design alternatives which add back-to-the-drawing board capabilities to knowledge-based mechanical CAD/CAM software programs. DOE

N91-22766*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
RSM 1.0 USER'S GUIDE: A RESUPPLY SCHEDULER USING INTEGER OPTIMIZATION
Larry A. Viterna, Robert D. Green, and David M. Reed (Wittenberg Univ., Springfield, OH.) May 1991 43 p
(NASA-TM-104380; E-6185; NAS 1.15:104380) Avail: NTIS HC/MF A03 CSCL 09B

The Resupply Scheduling Model (RSM) is a PC based, fully menu-driven computer program. It uses integer programming techniques to determine an optimum schedule to replace components on or before a fixed replacement period, subject to user defined constraints such as transportation mass and volume limits or available repair crew time. Principal input for RSJ includes properties such as mass and volume and an assembly sequence. Resource constraints are entered for each period corresponding to the component properties. Though written to analyze the electrical power system on the Space Station Freedom, RSM is quite general and can be used to model the resupply of almost any system subject to user defined resource constraints. Presented here is a step by step procedure for preparing the input, performing the analysis, and interpreting the results. Instructions for installing the program and information on the algorithms are given. Author

N91-22202# CISI Ingenierie, Toulouse (France).
MERCATOR: A DISTRIBUTED GROUND CONTROL SYSTEM FOR GEOSTATIONARY SATELLITE POSITIONING
P. Vielcanet, P. Moran, and H. Secretan (Centre National d'Etudes Spatiales, Toulouse, France) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 81-86 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22214# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
THE ANTENNA MANAGER SOFTWARE FOR THE BRAZILIAN SATELLITE: IMPLEMENTATION AND STUDY
Maria deFatimaMattielloFrancisco, Ana Maria Ambrioso (Sociedade Civil de Educacao Bras Cubas, Mogi das Cruzes, Brazil), and Mario Jose C. Ciurra *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 151-156 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22230# Academy of Sciences (USSR), Moscow. Inst. of Space Research.
THE AUTOMATIC RECONSTRUCTION OF 3-DIMENSIONAL SCENES FOR MARS ROVER OPERATIONS
M. I. Kolesnik *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 247-251 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22246# Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Milan. Space Div.
THE SHELL CONCEPT TO EASE THE DEVELOPMENT OF KNOWLEDGE-BASED SYSTEMS FOR SPACECRAFT CONTROL
S. Gusmeroli, M. Monti, and A. Pezzinga *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 353-358 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22254# VEGA Space Systems Engineering Ltd., Harpenden (England).
AN APPROACH FOR THE APPLICATION OF KNOWLEDGE BASED SYSTEMS TO THE PRODUCTION AND EXECUTION OF SPACECRAFT OPERATIONS PROCEDURES
Roger S. Thompson *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 409-414 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22260# Computer Technology Associates, Inc., Rockville, MD.
ALTERNATIVE LIFE CYCLE MODELS FOR SPACECRAFT MISSION OPERATIONS SOFTWARE DEVELOPMENT
H. J. Bender *In* ESA, Ground Data Systems for Spacecraft

Control Oct. 1990 p 443-448 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22261# Marcol Computer Systems Ltd., Darmstadt (Germany, F.R.).
ULYSSES SPACECRAFT CONTROL AND MONITORING SOFTWARE
R. W. Corkill *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 449-453 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22266# Societe d'Etudes des Systemes d'Automation, Toulouse (France).
OBJECT ORIENTED PROGRAMMING IN MMI: A SOFTWARE TOOL FOR ANALYSIS AND PLANIFICATION OF A RADAR IMAGING MISSION
K. VuTien and J. P. Aguttes (Centre National d'Etudes Spatiales, Toulouse, France) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 483-487 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22269# Technischer Uerberwachungs-Verein Rheinland e.V., Cologne (Germany, F.R.).
SAFETY IN SOFTWARE FOR MANNED MISSION CONTROL: A CLASSIFICATION METHODOLOGY
R. vomHoevel (European Space Agency. European Space Operations Center, Darmstadt, Germany, F.R.), H. Krebs, and M. Clendining *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 501-509 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22271# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
ESTABLISHING A SOFTWARE PRODUCT ASSURANCE DATABANK FOR SOFTWARE RELIABILITY DESIGN, DEVELOPMENT, AND ASSESSMENT
R. Borcz and R. Glasl *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 515-520 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22278# MATRA Espace, Toulouse (France).
HYPERMEDIA TOOL FOR OPERATIONAL PROCEDURE: CREATION AND UTILIZATION
J.-Y. Marson and P. Gremillon *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 559-562 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22285# SAT Control, Labege (France).
COMPUTER DIALOGUE TECHNIQUES FOR SATELLITE OPERATIONS
L. Buys, C. Durand, and G. Mace *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 601-606 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22287# Societe d'Etudes des Systemes d'Automation, Frankfurt (Germany, F.R.).
CONFIGURABLE SPACECRAFT CONTROL SYSTEMS
X. A. Debest and Bruno Mullet (European Space Agency. European Space Operations Center, Darmstadt, Germany, F.R.) *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 615-619 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22312*# Colorado State Univ., Fort Collins.
A FAST ALGORITHM FOR CONTROL AND ESTIMATION USING A POLYNOMIAL STATE-SPACE STRUCTURE
James R. Shults, Thomas Brubaker, and Gordon K. F. Lee (North Carolina State Univ., Raleigh.) *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 41-56 (For primary document see N91-22307 14-18)
(Grant NAG1-926)
Avail: NTIS HC/MF A20 CSCL 09B

N91-22314*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A FAST, RELIABLE ALGORITHM FOR COMPUTING FREQUENCY RESPONSES OF STATE SPACE MODELS
Matt Wette *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 71-78 (For primary document see N91-22307 14-18)
Avail: NTIS HC/MF A20 CSCL 09B

N91-22320*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
SERIAL AND PARALLEL COMPUTATION OF KANE'S EQUATIONS FOR MULTIBODY DYNAMICS
Amir Fijany *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 181-210 (For primary document see N91-22307 14-18)
Avail: NTIS HC/MF A20 CSCL 09B

N91-22327*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PDEMOD: SOFTWARE FOR CONTROL/STRUCTURES OPTIMIZATION
Lawrence W. Taylor, Jr. and David Zimmerman (Florida Univ., Gainesville.) *In its* Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 359-39 (For primary document see N91-22307 14-18)
Avail: NTIS HC/MF A20 CSCL 09B

N91-23022*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE VIRTUAL ENVIRONMENT DISPLAY SYSTEM
Michael W. McGreevy *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 3-9 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09B

N91-23038*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Visualization and Earth Science Applications Group.
THREE-DIMENSIONAL PERSPECTIVE VISUALIZATION
Kevin Hussey *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 144-146 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09B

62 COMPUTER SYSTEMS

Includes computer networks and special application computer systems.

N91-22767# Technische Univ., Berlin (Germany, F.R.). Fachbereich Informatik.
LARGE-GRAIN DATAFLOW COMPUTATION AND ITS ARCHITECTURAL SUPPORT Ph.D. Thesis
Kechang Dai 1988 196 p
(ETN-91-99256) Avail: NTIS HC/MF A09

Fundamental principles of DF (Data Flow) computations for solving problems related to algorithm parallelism in high performance computers are discussed and compared to von Neumann computations. Arvind's machine is used as an example to illustrate DF computation principles and the Manchester DF prototype is used as an implementation example. An architecture which is intended to combine the advantages of the DF computation with those of CF (Control Flow), based on a model of Large Grain Dataflow (LGD) computation, is proposed. By enabling loop

unraveling and parallel recursive procedure calls, high parallelism is achieved to make use of system resources. The incorporation of the efficient DSA (Data Structure Architecture) principle into the LGDG (LDG Graph) architecture makes it much more powerful than the pure DF computers in handling structured data. ESA

N91-23026*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Center for Space Microelectronics Technology.
HYPERSWITCH COMMUNICATION NETWORK
J. Peterson, M. Pniel, and E. Upchurch *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 42-52 Sponsored by Strategic Defense Initiative Organization, Washington DC and ESD, Hanscom AFB, MA (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09B

63 CYBERNETICS

Includes feedback and control theory, artificial intelligence, robotics and expert systems.

For related information see also *54 Man/System Technology and Life Support.*

N91-22768 Houston Univ., TX.
AN AI-BASED ARCHITECTURE OF SELF-STABILIZING FAULT TOLERANT DISTRIBUTED PROCESS CONTROL PROGRAMS AND ITS ANALYSIS Ph.D. Thesis
Ing-Ray Chen 1988 188 p
Avail: Univ. Microfilms Order No. DA9100576

Critical process-control systems must provide uninterrupted services even in the face of partial failures. An architecture based on the notion of self-stabilization and telescopic replication is proposed as a general framework for achieving fault tolerance for these systems. A process-control program is first decomposed into centralized and decentralized subgoals with the objective of simplifying program design. Then, decentralized subgoals are made inherently fault tolerant and assigned to real-time controllers for dealing with stringent real-time control tasks. Centralized subgoals are assigned to controllers which employ AI knowledge representation, planning, and learning mechanisms to make the architecture as a whole fault tolerant. A model is given for describing a process-control system and a systematic way of decomposing a control program's goal is presented in centralized and decentralized subgoals so as to facilitate organization of control processes in a hierarchical structure. Issues which may arise with decentralized decomposition, along with their possible solutions, are addressed and the notion of inherently fault tolerant programs resulting from decentralized decomposition is defined. For centralized subgoals AI learning and planning mechanisms were investigated to improve the system reliability by means of reducing the strategy formulation time, and reducing the response execution time. In learning, this involves the effect of learning capability on the reliability of the system and how a system can deal with unexpected situations. In planning, this involves the tradeoff analysis between the optimality of a control strategy and the satisfaction of a real-time constraint and the reliability assessment of various search strategies which are used most extensively in AI search paradigm. An AI-based knowledge representation method was also investigated for providing cost-effective fault tolerance for upper level controllers based on the notion of telescopic replication. Dissert. Abstr.

N91-22769*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE 1991 GODDARD CONFERENCE ON SPACE APPLICATIONS OF ARTIFICIAL INTELLIGENCE
James L. Rash, ed. Washington May 1991 361 p Conference held in Greenbelt, MD, 13-15 May 1991
(NASA-CP-3110; Rept-91B00064; NAS 1.55:3110) Avail: NTIS HC/MF A16 CSCL 09B

The purpose of this annual conference is to provide a forum in which current research and development directed at space applications of artificial intelligence can be presented and discussed. The papers in this proceeding fall into the following areas: Planning and scheduling, fault monitoring/diagnosis/recovery, machine vision, robotics, system development, information management, knowledge acquisition and representation, distributed systems, tools, neural networks, and miscellaneous applications. For individual titles, see N91-22770 through N91-22797.

N91-22770*# Computer Resources International A/S (Denmark).
OPTIMUM-AIV: A PLANNING AND SCHEDULING SYSTEM FOR SPACECRAFT AIV
M. M. Arentoft, Jens J. Fuchs, Y. Parrod, Andre Gasquet, J. Stader, I. Stokes, and H. Vadon (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 3-13 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

A project undertaken for the European Space Agency (ESA) is presented. The project is developing a knowledge based software system for planning and scheduling of activities for spacecraft assembly, integration, and verification (AIV). The system extends into the monitoring of plan execution and the plan repair phase. The objectives are to develop an operational kernel of a planning, scheduling, and plan repair tool, called OPTIMUM-AIV, and to provide facilities which will allow individual projects to customize the kernel to suit its specific needs. The kernel shall consist of a set of software functionalities for assistance in initial specification of the AIV plan, in verification and generation of valid plans and schedules for the AIV activities, and in interactive monitoring and execution problem recovery for the detailed AIV plans. Embedded in OPTIMUM-AIV are external interfaces which allow integration with alternative scheduling systems and project databases. The current status of the OPTIMUM-AIV project, as of Jan. 1991, is that a further analysis of the AIV domain has taken place through interviews with satellite AIV experts, a software requirement document (SRD) for the full operational tool was approved, and an architectural design document (ADD) for the kernel excluding external interfaces is ready for review. Author

N91-22771*# Intelligent Systems Lab., Chantilly, VA.
TDRSS MOMENTUM UNLOAD PLANNING
George R. Cross, Mitchell A. Potter, J. Douglass Whitehead, and James T. Smith *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 15-29 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

A knowledge-based system is described which monitors TDRSS telemetry for problems in the momentum unload procedure. The system displays TDRSS telemetry and commands in real time via X-windows. The system constructs a momentum unload plan which agrees with the preferences of the attitude control specialists and the momentum growth characteristics of the individual spacecraft. During the execution of the plan, the system monitors the progress of the procedure and watches for unexpected problems. Author

N91-22772*# Martin Marietta Corp., Denver, CO. Information Systems Group.
SHARING INTELLIGENCE: DECISION-MAKING INTERACTIONS BETWEEN USERS AND SOFTWARE IN MAESTRO
Amy L. Geoffroy, John R. Gohring, and Daniel L. Britt *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 31-44 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

By combining the best of automated and human decision-making in scheduling many advantages can accrue. The joint performance of the user and system is potentially much better than either alone. Features of the MAESTRO scheduling system serve to

illustrate concepts of user/software cooperation. MAESTRO may be operated at a user-determinable and dynamic level of autonomy. Because the system allows so much flexibility in the allocation of decision-making responsibilities, and provides users with a wealth of information and other support for their own decision-making, better overall schedules may result. Author

N91-22773*# Space Telescope Science Inst., Baltimore, MD.
TRANSFORMATION REBORN: A NEW GENERATION EXPERT SYSTEM FOR PLANNING HST OPERATIONS
Andrew Gerb *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 45-58 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

The Transformation expert system (TRANS) converts proposals for astronomical observations with the Hubble Space Telescope (HST) into detailed observing plans. It encodes expert knowledge to solve problems faced in planning and commanding HST observations to enable their processing by the Science Operations Ground System (SOGS). Among these problems are determining an acceptable order of executing observations, grouping of observations to enhance efficiency and schedulability, inserting extra observations when necessary, and providing parameters for commanding HST instruments. TRANS is currently an operational system and plays a critical role in the HST ground system. It was originally designed using forward-chaining provided by the OPS5 expert system language, but has been reimplemented using a procedural knowledge base. This reimplementation was forced by the explosion in the amount of OPS5 code required to specify the increasingly complicated situations requiring expert-level intervention by the TRANS knowledge base. This problem was compounded by the difficulty of avoiding unintended interaction between rules. To support the TRANS knowledge base, XCL, a small but powerful extension to Commom Lisp was implemented. XCL allows a compact syntax for specifying assignments and references to object attributes. XCL also allows the capability to iterate over objects and perform keyed lookup. The reimplementation of TRANS has greatly diminished the effort needed to maintain and enhance it. As a result of this, its functions have been expanded to include warnings about observations that are difficult or impossible to schedule or command, providing data to aid SPIKE, an intelligent planning system used for HST long-term scheduling, and providing information to the Guide Star Selection System (GSSS) to aid in determination of the long range availability of guide stars. Author

N91-22774*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
USING C TO BUILD A SATELLITE SCHEDULING EXPERT SYSTEM: EXAMPLES FROM THE EXPLORER PLATFORM PLANNING SYSTEM
David R. McLean, Alan Tuchman (Bendix Field Engineering Corp., Greenbelt, MD.), and William J. Potter *In its* The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 59-69 (For primary document see N91-22769 14-63)
(Contracts NAS5-31000; NAS5-27772)
Avail: NTIS HC/MF A16 CSCL 09B

Recently, many expert systems were developed in a LISP environment and then ported to the real world C environment before the final system is delivered. This situation may require that the entire system be completely rewritten in C and may actually result in a system which is put together as quickly as possible with little regard for maintainability and further evolution. With the introduction of high performance UNIX and X-windows based workstations, a great deal of the advantages of developing a first system in the LISP environment have become questionable. A C-based AI development effort is described which is based on a software tools approach with emphasis on reusability and maintainability of code. The discussion starts with simple examples of how list processing can easily be implemented in C and then proceeds to the implementations of frames and objects which use dynamic memory allocation. The implementation of procedures which use depth first search, constraint propagation, context switching and a blackboard-like simulation environment are described. Techniques for managing the complexity of C-based AI software are noted, especially the object-oriented techniques of data encapsulation and incremental development. Finally, all these concepts are put together by describing the components of planning software called the Planning And Resource Reasoning (PARR) shell. This shell was successfully utilized for scheduling services of the Tracking and Data Relay Satellite System for the Earth Radiation Budget Satellite since May 1987 and will be used for operations scheduling of the Explorer Platform in November 1991. Author

N91-22775*# Space Telescope Science Inst., Baltimore, MD.
LONG RANGE SCIENCE SCHEDULING FOR THE HUBBLE SPACE TELESCOPE
Glenn Miller and Mark Johnston *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 71-82 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

Observations with NASA's Hubble Space Telescope (HST) are scheduled with the assistance of a long-range scheduling system (SPIKE) that was developed using artificial intelligence techniques. In earlier papers, the system architecture and the constraint representation and propagation mechanisms were described. The development of high-level automated scheduling tools, including tools based on constraint satisfaction techniques and neural networks is described. The performance of these tools in scheduling HST observations is discussed. Author

N91-22776*# Colorado Univ., Boulder. Lab. for Atmospheric and Space Physics.
AI TECHNIQUES FOR A SPACE APPLICATION SCHEDULING PROBLEM
N. Thalman, T. Sparn, L. Jaffres, D. Gablehouse, D. Judd, and C. Russell *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 83-93 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

Scheduling is a very complex optimization problem which can be categorized as an NP-complete problem. NP-complete problems are quite diverse, as are the algorithms used in searching for an optimal solution. In most cases, the best solutions that can be derived for these combinatorial explosive problems are near-optimal solutions. Due to the complexity of the scheduling problem, artificial intelligence (AI) can aid in solving these types of problems. Some of the factors are examined which make space application scheduling problems difficult and presents a fairly new AI-based technique called tabu search as applied to a real scheduling application. the specific problem is concerned with scheduling application. The specific problem is concerned with scheduling solar and stellar observations for the SOLar-STellar Irradiance Comparison Experiment (SOLSTICE) instrument in a constrained environment which produces minimum impact on the other instruments and maximizes target observation times. The SOLSTICE instrument will gly on-board the Upper Atmosphere Research Satellite (UARS) in 1991, and a similar instrument will fly on the earth observing system (Eos). Author

N91-22777*# Mitre Corp., Houston, TX.
A FAILURE DIAGNOSIS AND IMPACT ASSESSMENT PROTOTYPE FOR SPACE STATION FREEDOM
Carolyn G. Baker and Christopher A. Marsh *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 97-111 (For primary document see N91-22769 14-63)
(Contract NAS9-18057)
Avail: NTIS HC/MF A16 CSCL 09B

NASA is investigating the use of advanced automation to enhance crew productivity for Space Station Freedom in numerous

areas, one being failure management. A prototype is described that diagnoses failure sources and assesses the future impacts of those failures on other Freedom entities. Author

N91-22778*# Mitre Corp., Houston, TX.
A FAILURE RECOVERY PLANNING PROTOTYPE FOR SPACE STATION FREEDOM
David G. Hammen and Christine M. Kelly *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 113-127 (For primary document see N91-22769 14-63)
(Contract NAS9-18057)
Avail: NTIS HC/MF A16 CSCL 09B

NASA is investigating the use of advanced automation to enhance crew productivity for Space Station Freedom in numerous areas, including failure management. A prototype is described that uses various advanced automation techniques to generate courses of action whose intents are to recover from a diagnosed failure, and to do so within the constraints levied by the failure and by Freedom's configuration and operating conditions. Author

N91-22779*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE GENERIC SPACECRAFT ANALYST ASSISTANT (GENSAA): A TOOL FOR AUTOMATING SPACECRAFT MONITORING WITH EXPERT SYSTEMS
Peter M. Hughes and Edward C. Luczak (Computer Sciences Corp., Beltsville, MD.) *In its* The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 129-139 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

Flight Operations Analysts (FOAs) in the Payload Operations Control Center (POCC) are responsible for monitoring a satellite's health and safety. As satellites become more complex and data rates increase, FOAs are quickly approaching a level of information saturation. The FOAs in the spacecraft control center for the COBE (Cosmic Background Explorer) satellite are currently using a fault isolation expert system named the Communications Link Expert Assistance Resource (CLEAR), to assist in isolating and correcting communications link faults. Due to the success of CLEAR and several other systems in the control center domain, many other monitoring and fault isolation expert systems will likely be developed to support control center operations during the early 1990s. To facilitate the development of these systems, a project was initiated to develop a domain specific tool, named the Generic Spacecraft Analyst Assistant (GenSAA). GenSAA will enable spacecraft analysts to easily build simple real-time expert systems that perform spacecraft monitoring and fault isolation functions. Lessons learned during the development of several expert systems at Goddard, thereby establishing the foundation of GenSAA's objectives and offering insights in how problems may be avoided in future project, are described. This is followed by a description of the capabilities, architecture, and usage of GenSAA along with a discussion of its application to future NASA missions. Author

N91-22780*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
REPRESENTING FUNCTIONS/PROCEDURES AND PROCESSES/STRUCTURES FOR ANALYSIS OF EFFECTS OF FAILURES ON FUNCTIONS AND OPERATIONS
Jane T. Malin and Daniel B. Leifker (Mitre Corp., Houston, TX.) *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 141-151 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

Current qualitative device and process models represent only the structure and behavior of physical systems. However, systems in the real world include goal-oriented activities that generally cannot be easily represented using current modeling techniques. An extension of a qualitative modeling system, known as functional modeling, which captures goal-oriented activities explicitly is proposed and how they may be used to support intelligent automation and fault management is shown. Author

N91-22781*# Sverdrup Technology, Inc., Brook Park, OH.
AUTONOMOUS POWER SYSTEM INTELLIGENT DIAGNOSIS AND CONTROL
Mark J. Ringer, Todd M. Quinn, and Anthony Merolla *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 153-167 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

The Autonomous Power System (APS) project at NASA Lewis Research Center is designed to demonstrate the abilities of integrated intelligent diagnosis, control, and scheduling techniques to space power distribution hardware. Knowledge-based software provides a robust method of control for highly complex space-based power systems that conventional methods do not allow. The project consists of three elements: the Autonomous Power Expert System (APEX) for fault diagnosis and control, the Autonomous Intelligent Power Scheduler (AIPS) to determine system configuration, and power hardware (Brassboard) to simulate a space based power system. The operation of the Autonomous Power System as a whole is described and the responsibilities of the three elements - APEX, AIPS, and Brassboard - are characterized. A discussion of the methodologies used in each element is provided. Future plans are discussed for the growth of the Autonomous Power System. Author

N91-22782*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
A MACHINE INDEPENDENT EXPERT SYSTEM FOR DIAGNOSING ENVIRONMENTALLY INDUCED SPACECRAFT ANOMALIES
Mark J. Rolincik *In its* The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 169-179 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

A new rule-based, machine independent analytical tool for diagnosing spacecraft anomalies, the EnviroNET expert system, was developed. Expert systems provide an effective method for storing knowledge, allow computers to sift through large amounts of data pinpointing significant parts, and most importantly, use heuristics in addition to algorithms which allow approximate reasoning and inference, and the ability to attack problems not rigidly defines. The EviroNET expert system knowledge base currently contains over two hundred rules, and links to databases which include past environmental data, satellite data, and previous known anomalies. The environmental causes considered are bulk charging, single event upsets (SEU), surface charging, and total radiation dose. Author

N91-22783*# Symbiotics, Inc., Cambridge, MA.
A HIERARCHICAL DISTRIBUTED CONTROL MODEL FOR COORDINATING INTELLIGENT SYSTEMS
Richard M. Adler *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 183-197 (For primary document see N91-22769 14-63)
(Contracts NAS10-11606; DAAB10-87-C-0053)
Avail: NTIS HC/MF A16 CSCL 09B

A hierarchical distributed control (HDC) model for coordinating cooperative problem-solving among intelligent systems is described. The model was implemented using SOCIAL, an innovative object-oriented tool for integrating heterogeneous, distributed software systems. SOCIAL embeds applications in 'wrapper' objects called Agents, which supply predefined capabilities for distributed communication, control, data specification, and translation. The HDC model is realized in SOCIAL as a 'Manager'Agent that coordinates interactions among application Agents. The HDC Manager: indexes the capabilities of application Agents; routes request messages to suitable server Agents; and stores results in a commonly accessible

'Bulletin-Board'. This centralized control model is illustrated in a fault diagnosis application for launch operations support of the Space Shuttle fleet at NASA, Kennedy Space Center. Author

N91-22784*# Martin Marietta Aerospace, Denver, CO.
MACHINE VISION BASED TELEOPERATION AID
William A. Hoff, Lance B. Gatrell, and John R. Spofford *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 199-213 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

When teleoperating a robot using video from a remote camera, it is difficult for the operator to gauge depth and orientation from a single view. In addition, there are situations where a camera mounted for viewing by the teleoperator during a teleoperation task may not be able to see the tool tip, or the viewing angle may not be intuitive (requiring extensive training to reduce the risk of incorrect or dangerous moves by the teleoperator). A machine vision based teleoperator aid is presented which uses the operator's camera view to compute an object's pose (position and orientation), and then overlays onto the operator's screen information on the object's current and desired positions. The operator can choose to display orientation and translation information as graphics and/or text. This aid provides easily assimilated depth and relative orientation information to the teleoperator. The camera may be mounted at any known orientation relative to the tool tip. A preliminary experiment with human operators was conducted and showed that task accuracies were significantly greater with than without this aid. Author

N91-22785*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
A COLOR-CODED VISION SCHEME FOR ROBOTICS
Kelley Tina Johnson *In its* The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 215-226 (For primary document see N91-22769 14-63)
(Grant NAG5-1382)
Avail: NTIS HC/MF A16 CSCL 09B

Most vision systems for robotic applications rely entirely on the extraction of information from gray-level images. Humans, however, regularly depend on color to discriminate between objects. Therefore, the inclusion of color in a robot vision system seems a natural extension of the existing gray-level capabilities. A method for robot object recognition using a color-coding classification scheme is discussed. The scheme is based on an algebraic system in which a two-dimensional color image is represented as a polynomial of two variables. The system is then used to find the color contour of objects. In a controlled environment, such as that of the in-orbit space station, a particular class of objects can thus be quickly recognized by its color. Author

N91-22786*# Computer Resources International A/S (Denmark).
EXPERT OPERATOR'S ASSOCIATE: A KNOWLEDGE BASED SYSTEM FOR SPACECRAFT CONTROL
Mogens Nielsen, Klaus Grue, and Francois Lecouat (MATRA Espace, Toulouse, France) *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 227-237 (For primary document see N91-22769 14-63)
(Contract ESA-7627/88/NL/DG)
Avail: NTIS HC/MF A16 CSCL 09B

The Expert Operator's Associate (EOA) project is presented which studies the applicability of expert systems for day-to-day space operations. A prototype expert system is developed, which operates on-line with an existing spacecraft control system at the European Space Operations Centre, and functions as an 'operator's assistant' in controlling satellites. The prototype is demonstrated using an existing real-time simulation model of the MARECS-B2 telecommunication satellite. By developing a prototype system, the extent to which reliability and effectivens of operations can be enhanced by AI based support is examined. In addition the study examines the questions of acquisition and representation of the 'knowledge' for such systems, and the feasibility of 'migration' of some (currently) ground-based functions into future spaceborne autonomous systems. Author

N91-22787*# Computer Sciences Corp., Beltsville, MD.
VALIDATION AND VERIFICATION OF EXPERT SYSTEMS
Lewey Gilstrap *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 241-248 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

Validation and verification (V&V) are procedures used to evaluate system structure or behavior with respect to a set of requirements. Although expert systems are often developed as a series of prototypes without requirements, it is not possible to perform V&V on any system for which requirements have not been prepared. In addition, there are special problems associated with the evaluation of expert systems that do not arise in the evaluation of conventional systems, such as verification of the completeness and accuracy of the knowledge base. The criticality of most NASA missions make it important to be able to certify the performance of the expert systems used to support these mission. Recommendations for the most appropriate method for integrating V&V into the Expert System Development Methodology (ESDM) and suggestions for the most suitable approaches for each stage of ESDM development are presented. Author

N91-22788*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TECHNIQUES AND IMPLEMENTATION OF THE EMBEDDED RULE-BASED EXPERT SYSTEM USING Ada
Eugene M. Liberman (Sverdrup Technology, Inc., Brook Park, OH.) and Robert E. Jones *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 249-255 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

Ada is becoming an increasingly popular programming language for large Government-funded software projects. Ada with its portability, transportability, and maintainability lends itself well to today's complex programming environment. In addition, expert systems have also assured a growing role in providing human-like reasoning capability and expertise for computer systems. The integration of expert system technology with Ada programming language, specifically a rule-based expert system using an ART-Ada (Automated Reasoning Tool for Ada) system shell is discussed. The NASA Lewis Research Center was chosen as a beta test site for ART-Ada. The test was conducted by implementing the existing Autonomous Power EXpert System (APEX), a Lisp-base power expert system, in ART-Ada. Three components, the rule-based expert system, a graphics user interface, and communications software make up SMART-Ada (Systems fault Management with ART-Ada). The main objective, to conduct a beta test on the ART-Ada rule-based expert system shell, was achieved. The system is operational. New Ada tools will assist in future successful projects. ART-Ada is one such tool and is a viable alternative to the straight Ada code when an application requires a rule-based or knowledge-based approach. B.G.

N91-22789*# Syscon Corp., Washington, DC.
A REUSABLE KNOWLEDGE ACQUISITION SHELL: KASH
Christopher Westphal, Stephen Williams, and Virginia Keech *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 257-272 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

KASH (Knowledge Acquisition SHell) is proposed to assist a knowledge engineer by providing a set of utilities for constructing knowledge acquisition sessions based on interviewing techniques. The information elicited from domain experts during the sessions is guided by a question dependency graph (QDG). The QDG defined

by the knowledge engineer, consists of a series of control questions about the domain that are used to organize the knowledge of an expert. The content information supplies by the expert, in response to the questions, is represented in the form of a concept map. These maps can be constructed in a top-down or bottom-up manner by the QDG and used by KASH to generate the rules for a large class of expert system domains. Additionally, the concept maps can support the representation of temporal knowledge. The high degree of reusability encountered in the QDG and concept maps can vastly reduce the development times and costs associated with producing intelligent decision aids, training programs, and process control functions. Author

N91-22790*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
CAPTURING FLIGHT SYSTEM TEST ENGINEERING EXPERTISE: LESSONS LEARNED
Irene Wong Woerner *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 273-283 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

Within a few years, JPL will be challenged by the most active mission set in history. Concurrently, flight systems are increasingly more complex. Presently, the knowledge to conduct integration and test of spacecraft and large instruments is held by a few key people, each with many years of experience. JPL is in danger of losing a significant amount of this critical expertise, through retirement, during a period when demand for this expertise is rapidly increasing. The most critical issue at hand is to collect and retain this expertise and develop tools that would ensure the ability to successfully perform the integration and test of future spacecraft and large instruments. The proposed solution was to capture and codity a subset of existing knowledge, and to utilize this captured expertise in knowledge-based systems. First year results and activities planned for the second year of this on-going effort are described. Topics discussed include lessons learned in knowledge acquisition and elicitation techniques, life-cycle paradigms, and rapid prototyping of a knowledge-based advisor (Spacecraft Test Assistant) and a hypermedia browser (Test Engineering Browser). The prototype Spacecraft Test Assistant supports a subset of integration and test activities for flight systems. Browser is a hypermedia tool that allows users easy perusal of spacecraft test topics. A knowledge acquisition tool called ConceptFinder which was developed to search through large volumes of data for related concepts is also described and is modified to semi-automate the process of creating hypertext links. Author

N91-22791*# Idaho National Engineering Lab., Idaho Falls.
A PROVEN KNOWLEDGE-BASED APPROACH TO PRIORITIZING PROCESS INFORMATION
Daniel R. Corsberg *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 287-293 (For primary document see N91-22769 14-63)
(Contract DE-AC07-76ID-01570)
Avail: NTIS HC/MF A16 CSCL 09B

Many space-related processes are highly complex systems subject to sudden, major transients. In any complex process control system, a critical aspect is rapid analysis of the changing process information. During a disturbance, this task can overwhelm humans as well as computers. Humans deal with this by applying heuristics in determining significant information. A simple, knowledge-based approach to prioritizing information is described. The approach models those heuristics that humans would use in similar circumstances. The approach described has received two patents and was implemented in the Alarm Filtering System (AFS) at the Idaho National Engineering Laboratory (INEL). AFS was first developed for application in a nuclear reactor control room. It has since been used in chemical processing applications, where it has had a significant impact on control room environments. The approach uses knowledge-based heuristics to analyze data from process instrumentation and respond to that data according to knowledge encapsulated in objects and rules. While AFS cannot perform the complete diagnosis and control task, it has proven to be extremely effective at filtering and prioritizing information. AFS was used for over two years as a first level of analysis for human diagnosticians. Given the approach's proven track record in a wide variety of practical applications, it should be useful in both ground- and space-based systems. Author

N91-22792*# College of William and Mary, Williamsburg, VA. Dept. of Computer Science.
DESIGN OF AN INTELLIGENT INFORMATION SYSTEM FOR IN-FLIGHT EMERGENCY ASSISTANCE
Stefan Feyock and Stamos Karamouzis *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 295-306 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

The present research has as its goal the development of AI tools to help flight crews cope with in-flight malfunctions. The relevant tasks in such situations include diagnosis, prognosis, and recovery plan generation. Investigation of the information requirements of these tasks has shown that the determination of paths figures largely: what components or systems are connected to what others, how are they connected, whether connections satisfying certain criteria exist, and a number of related queries. The formulation of such queries frequently requires capabilities of the second-order predicate calculus. An information system is described that features second-order logic capabilities, and is oriented toward efficient formulation and execution of such queries. Author

N91-22793*# George Mason Univ., Fairfax, VA. Dept. of Physics.
PRELIMINARY RESULTS OF INVESTIGATIONS INTO THE USE OF ARTIFICIAL NEURAL NETWORKS FOR DISCRIMINATING GAS CHROMATOGRAPH MASS SPECTRA OF REMOTE SAMPLES
Harold A. Geller, Eugene Norris, and Archibald Warnock, III (ST Systems Corp., Lanham, MD.) *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 307-316 Prepared in cooperation with Research and Data Systems, Inc., Greenbelt, MD (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

Neural networks trained using mass spectra data from the National Institute of Standards and Technology (NIST) are studied. The investigations also included sample data from the gas chromatograph mass spectrometer (GCMS) instrument aboard the Viking Lander, obtained from the National Space Science Data Center. The work performed to data and the preliminary results from the training and testing of neural networks are described. These preliminary results are presented for the purpose of determining the viability of applying artificial neural networks in discriminating mass spectra samples from remote instrumentation such as the Mars Rover Sample Return Mission and the Cassini Probe. Author

N91-22794*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
METAMORPHOSES OF ONAV CONSOLE OPERATIONS: FROM PROTOTYPE TO REAL TIME APPLICATION
Malise Millis and Lui Wang *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 317-326 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

The ONAV (Onboard Navigation) Expert System is being developed as a real time console assistant to the ONAV flight controller for use in the Mission Control Center at the Johnson Space Center. Currently the entry and rendezvous systems are in verification, and the ascent is being prototyped. To arrive at this stage, from a prototype to real world application, the ONAV project has had to deal with not only AI issues but operating environment

issues. The AI issues included the maturity of AI languages and the debugging tools, what is verification, and availability, stability, and the size of the expert pool. The environmental issues included real time data acquisition, hardware stability, and how to achieve acceptance by users and management. Author

N91-22795*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
LESSONS LEARNED IN THE DEVELOPMENT OF THE STOL INTELLIGENT TUTORING SYSTEM
Thomas Seamster, Clifford Baker (Carlow Associates, Inc., Fairfax, VA.), and Troy Ames *In its* The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 327-338 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

Lessons learned during the development of the NASA Systems Test and Operations Language (STOL) Intelligent Tutoring System (ITS), being developed at NASA Goddard Space Flight Center are presented. The purpose of the intelligent tutor is to train STOL users by adapting tutoring based on inferred student strengths and weaknesses. This system has been under development for over one year and numerous lessons learned have emerged. These observations are presented in three sections, as follows. The first section addresses the methodology employed in the development of the STOL ITS and briefly presents the ITS architecture. The second presents lessons learned, in the areas of: intelligent tutor development; documentation and reporting; cost and schedule control; and tools and shells effectiveness. The third section presents recommendations which may be considered by other ITS developers, addressing: access, use and selection of subject matter experts; steps involved in ITS development; use of ITS interface design prototypes as part of knowledge engineering; and tools and shells effectiveness. Author

N91-22796*# Sverdrup Technology, Inc., Brook Park, OH.
SPACE COMMUNICATIONS ARTIFICIAL INTELLIGENCE FOR LINK EVALUATION TERMINAL (SCAILET)
Anoosh Shahidi *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 339-351 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

A software application to assis end-users of the Link Evaluation Terminal (LET) for satellite communication is being developed. This software application incorporates artificial intelligence (AI) techniques and will be deployed as an interface to LET. The high burst rate (HBR) LET provides 30 GHz transmitting/20 GHz receiving, 220/110 Mbps capability for wideband communications technology experiments with the Advanced Communications Technology Satellite (ACTS). The HBR LET and ACTS are being developed at the NASA Lewis Research Center. The HBR LET can monitor and evaluate the integrity of the HBR communications uplink and downlink to the ACTS satellite. The uplink HBR transmission is performed by bursting the bit-pattern as a modulated signal to the satellite. By comparing the transmitted bit pattern with the received bit pattern, HBR LET can determine the bit error rate BER) under various atmospheric conditions. An algorithm for power augmentation is applied to enhance the system's BER performance at reduced signal strength caused by adverse conditions. Programming scripts, defined by the design engineer, set up the HBR LET terminal by programming subsystem devices through IEEE488 interfaces. However, the scripts are difficult to use, require a steep learning curve, are cryptic, and are hard to maintain. The combination of the learning curve and the complexities involved with editing the script files may discourage end-users from utilizing the full capabilities of the HBR LET system. An intelligent assistant component of SCAILET that addresses critical end-user needs in the programming of the HBR LET system as anticipated by its developers is described. A close look is taken at the various steps involved in writing ECM software for a C&P, computer and at how the intelligent assistant improves the HBR LET system and enhances the end-user's ability to perform the experiments. Author

N91-22797*# Boeing Computer Services Co., Seattle, WA. Advanced Technology Center.
KNOWLEDGE REPOSITORIES FOR MULTIPLE USES
Keith Williamson and Patricia Riddle *In* NASA. Goddard Space Flight Center, The 1991 Goddard Conference on Space Applications of Artificial Intelligence May 1991 p 353-367 (For primary document see N91-22769 14-63)
Avail: NTIS HC/MF A16 CSCL 09B

In the life cycle of a complex physical device or part, for example, the docking bay door of the Space Station, there are many uses for knowledge about the device or part. The same piece of knowledge might serve several uses. Given the quantity and complexity of the knowledge that must be stored, it is critical to maintain the knowledge in one repository, in one form. At the same time, because of quantity and complexity of knowledge that must be used in life cycle applications such as cost estimation, re-design, and diagnosis, it is critical to automate such knowledge uses. For each specific use, a knowledge base must be available and must be in a from that promotes the efficient performance of that knowledge base. However, without a single source knowledge repository, the cost of maintaining consistent knowledge between multiple knowledge bases increases dramatically; as facts and descriptions change, they must be updated in each individual knowledge base. A use-neutral representation of a hydraulic system for the F-111 aircraft was developed. The ability to derive portions of four different knowledge bases is demonstrated from this use-neutral representation: one knowledge base is for re-design of the device using a model-based reasoning problem solver; two knowledge bases, at different levels of abstraction, are for diagnosis using a model-based reasoning solver; and one knowledge base is for diagnosis using an associational reasoning problem solver. It was shown how updates issued against the single source use-neutral knowledge repository can be propagated to the underlying knowledge bases. Author

N91-22798# Yale Univ., New Haven, CT.
A NEURAL NETWORK APPROACH TO MODEL-BASED RECOGNITION Final Report, 1 Dec. 1987 - 1 Mar. 1990
Gene R. Gindi 26 Dec. 1990 29 p
(Contract F49620-88-C-0025)
(AD-A231835; AFOSR-91-0009TR) Avail: NTIS HC/MF A03 CSCL 20/6

This project grew out of earlier work in which an approach to visual object recognition as an associative memory problem was pursued. The big problem with this earlier approach is that objects must be recognized regardless of changes in position, rotation, scaling, and a host of other deformations. One may store iconic patterns directly in a memory and design such invariances directly into the connection pattern, but the circuits quickly become complicated. We follow the approach taken in traditional computer vision systems and store relational models instead of iconic models into the circuit, and demand that the input data itself be organized into such a relational structure and optimally matched to the nearest model. Relational models are designed to automatically capture the desired invariances; the perceptual organization of input data into relational structure proceeds simultaneously with the matching process. Like some associative memory approaches, this one also uses objective functions for specification of the problem and design of the circuit. Early work on optical implementations was also continued in this grant. The original work focused on the use of optics for fast recognition of two dimensional geometrical patterns independent of scale, rotation, and translation. By stages, the focus shifted toward implementation of neural nets to accomplish the same goal, and, by extension, toward the general problem of optical interconnects. GRA

N91-22799# Georgia Tech Research Inst., Atlanta. Artificial Intelligence Branch.
THE DEVELOPMENT OF A RESEARCH ENVIRONMENT FOR NEURAL NETWORKS: INSTANTIATING NEOCOGNITIONS
Andrew J. Czuchry, Jr. 21 Dec. 1990 36 p
(AD-A231995; GTRI/AIB/TR-901221) Avail: NTIS HC/MF A03 CSCL 12/9

Neural networks can be thought of as combinations of generic pieces linked together in varying architectures. Many different models and architectures have been presented in the published literature. Networks may differ both in the characterization of their pieces and in the connection patterns of those pieces. In order to exploit the similarities between models, incorporate the differences between models, and automate the process of linking the pieces together, a prototype of a generalized research environment for neural networks is being developed. The main virtue of this generalized environment is the flexibility it provides for testing neural network architectural and processing decisions without having to write programs. The environment encompasses the ability to specify desired characteristics (e.g., activation functions, connection masks, sub-net sizes) as parameters to network creation functions; it does not force a programmer to combine such characteristics by altering the program code itself. This paper initially introduces the generalized research environment, subsequently discusses the architecture of a test case network (the neocognitron), and finally presents the initial results in testing a neocognitron instantiated by the environment. GRA

N91-22800# Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
AN IDENTIFICATION PERSPECTIVE ON ROBUSTNESS ISSUES IN ADAPTIVE POLE ASSIGNMENT
Jan Willem Polderman and Iven Mareels (Newcastle Univ., Australia) 12 Nov. 1990 8 p
(Memo-904; ISSN-0169-2690; ETN-91-99142) Avail: NTIS HC/MF A02

The properties of a closed loop system, subject to bounded disturbances are analyzed when a pole placement control law is implemented on the basis of a model that cannot be falsified by the resulting input/output data. Such models are the best that can be obtained from any identification method driven by the prediction error in closed loop and given the uncertainty on the disturbance. In the absence of disturbances such a model would give rise to closed loop behavior as if the poles are assigned. However, if the presence of arbitrary small disturbances is assumed, such a result does not even hold approximately and only stability can be guaranteed, poleplacement may not be achieved. As a consequence, the system behavior is not continuous in the magnitude of the upperbound of the disturbances. These results are relevant in the context of robust adaptive pole assignment. ESA

N91-22801# Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
PRINCIPLES OF OPTIMAL CONTROL THEORY
H. Nijmeijer 23 Nov. 1990 34 p
(Memo-908; ISSN-0169-2690; ETN-91-99145) Avail: NTIS HC/MF A03

An exposition of standard aspects of optimal control problems for nonlinear control systems of the form $x = f(x,u)$ is given. The necessary conditions for optimality of an input described in the celebrated Pontryagin maximum principle is included. The relation with the Hamilton-Jacobi-Bellman equation from the theory of dynamic programming is discussed. ESA

N91-22802# Bristol Univ. (England). Dept. of Aerospace Engineering.
A KNOWLEDGE ENGINEERING APPROACH TO RISK ANALYSIS IN THE HOTOL PROJECT B.S. Thesis
I. L. Mombru Jun. 1990 61 p
(BU-512; ETN-91-99205) Avail: NTIS HC/MF A04

The trend for industrial projects to overrun both deadlines and budgets has initiated the development of risk analysis techniques. Many of these fail to address key issues that require a reconciliation of quantitative appraisals of risk. This project adopts an artificial intelligence approach, in order to tackle this problem. FRIL, a support logic programming language, is used and offers two new angles of attack. Its structure models quantitative and qualitative information in a common framework. The support logic facility allows a representation of heuristic knowledge and uncertainty, and thus offers a certain measure of risk. These ideas are tested on the HOTOL project. A first model provides a global assessment of risk, while a second focuses on development costs, a subset of the 'global' model. Both highlight the strengths and weaknesses of such an approach, thus laying the foundations for further work in this field. ESA

N91-22803# Technische Univ., Eindhoven (Netherlands).
THE H-INFINITY CONTROL PROBLEM: A STATE SPACE APPROACH Ph.D. Thesis
Antoine Arij Stoorvogel 1990 238 p
(ETN-91-99215) Avail: NTIS HC/MF A11

A number of natural problems whose solutions depend on the results of H infinity control are introduced with the aim of justifying research effort in the area of H infinity control. The importance of robustness is formulated and explained and the basic H infinity control problem is outlined. The study on robustness outlines the importance of the problems of uncertain systems and the gap metric which are detailed later. These problems are formulated with the same objective of improving the robustness although from a completely different point of view and both have a solution with is intimately connected to H infinity control. The mixed sensitivity problem is explained. These aspects of the time domain approach to H infinity control are investigated: singular systems, differential games and discrete time systems. Existing theorems are generalized, and it is believed that H infinity will lead to robust and reliable controllers but that much work must be done to tackle real life control problems in a structured and reliable way. ESA

N91-22804*# Washington Univ., Seattle. Dept. of Aeronautical and Astronautics.
RELIABLE NUMERICAL COMPUTATION IN AN OPTIMAL OUTPUT-FEEDBACK DESIGN
Brett VanSteenwyk and Uy-Loi Ly 8 May 1991 18 p
(Grant NAG2-691)
(NASA-CR-188191; NAS 1.26:188191) Avail: NTIS HC/MF A03 CSCL 09B

A reliable algorithm is presented for the evaluation of a quadratic performance index and its gradients with respect to the controller design parameters. The algorithm is a part of a design algorithm for optimal linear dynamic output-feedback controller that minimizes a finite-time quadratic performance index. The numerical scheme is particularly robust when it is applied to the control-law synthesis for systems with densely packed modes and where there is a high likelihood of encountering degeneracies in the closed-loop eigensystem. This approach through the use of an accurate Pade series approximation does not require the closed-loop system matrix to be diagonalizable. The algorithm was included in a control design package for optimal robust low-order controllers. Usefulness of the proposed numerical algorithm was demonstrated using numerous practical design cases where degeneracies occur frequently in the closed-loop system under an arbitrary controller design initialization and during the numerical search. Author

N91-22245# MATRA Espace, Toulouse (France).
KNOWLEDGE-BASED SYSTEMS FOR SPACECRAFT CONTROL: KEYNOTE ADDRESS
Jean-Michel Darroy *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 345-351 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22247# Ford Aerospace and Communications Corp., Houston, TX.
MONITORING SHUTTLE ELECTRICAL SYSTEMS USING ARTIFICIAL NEURAL NETWORKS
George C. Scheuch *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 359-363 (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99

N91-22310*# Howard Univ., Washington, DC. Dept. of Electrical Engineering.
OPTIMAL CONTROL OF SYSTEMS WITH CAPACITY: RELATED NOISES
Milfang Ruan and Ajit K. Choudhury *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 23-34 (For primary document see N91-22307 14-18)
Avail: NTIS HC/MF A20 CSCL 09B

N91-22313*# Illinois Univ., Chicago. Lab. for Advanced Computing.
SUPERCOMPUTER OPTIMIZATIONS FOR STOCHASTIC OPTIMAL CONTROL APPLICATIONS
Siu-Leung Chung, Floyd B. Hanson, and Huihuang Xu *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 57-70 Sponsored in part by ANL (For primary document see N91-22307 14-18)
(Grant NSF DMS-88-06099)
Avail: NTIS HC/MF A20 CSCL 09B

N91-22329*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.
CONTROL EFFORT ASSOCIATED WITH MODEL REFERENCE ADAPTIVE CONTROL FOR VIBRATION DAMPING
Richard Scott Messer and Raphael T. Haftka *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 1 Mar. 1991 p 419-441 (For primary document see N91-22307 14-18)
(Grant NAG1-603)
Avail: NTIS HC/MF A20 CSCL 09B

N91-22342*# Carleton Univ., Ottawa (Ontario). Dept. of Mechanical and Aerospace Engineering.
DYNAMICS MODELING AND ADAPTIVE CONTROL OF FLEXIBLE MANIPULATORS
J. Z. Sasiadek *In* NASA. Langley Research Center, Fourth NASA Workshop on Computational Control of Flexible Aerospace Systems, Part 2 Mar. 1991 p 727-741 (For primary document see N91-22331 14-18)
Avail: NTIS HC/MF A20 CSCL 09B

N91-23027*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
BIOLOGICAL NEURAL NETWORKS AS MODEL SYSTEMS FOR DESIGNING FUTURE PARALLEL PROCESSING COMPUTERS
Muriel D. Ross *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 53-61 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09B

N91-23060*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
CONTROL SYSTEM SOFTWARE, SIMULATION, AND ROBOTIC APPLICATIONS
Harold P. Frisch *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 315-321 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09B

64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

N91-22805*# Grumman Aerospace Corp., Bethpage, NY.
ADDENDUM TO THE DYCAST USER'S MANUAL DESCRIBING THE CURVED, WARP BEAM FINITE ELEMENT Final Report
L. M. Kutt and A. B. Pifko Washington NASA May 1991 51 p Prepared for LMSC, Palo Alto, CA
(Contract NAS1-18444)
(NASA-CR-4362; NAS 1.26:4362; RE-780) Avail: NTIS HC/MF A04 CSCL 12A

DYCAST is a finite element computer program for the nonlinear transient dynamic analysis of structures. As part of the Computational Structural Mechanics (CSM) research program of NASA, the Grumman CRC is developing capabilities in its DYCAST software system for the analysis of aerospace structures made of composite materials. One result of this development effort is that a curved, linear, thin walled beam element was incorporated into the DYCAST library of finite elements. The formulation of this new element, called the WARP element, includes both shear deformations and nonuniform torsion (restrained warping). The basic concepts, the input data, and several example problems essential to the DYCAST analyst for the successful use the WARP element are described. Author

N91-22806# Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
A NOTE ON K(SUB 4)-CLOSURES IN HAMILTONIAN GRAPH THEORY
H. J. Broersma Nov. 1990 8 p
(Memo-903; ISSN-0169-2690; ETN-91-99141) Avail: NTiS HC/MF A02

Let G = (V,E) be a 2-connected graph. Two vertices u and v of G are called a pair if u and v are the vertices of degree two of an induced subgraph of G which is isomorphic to K(sub 4) minus an edge. Let x and y be the common neighbors of a K(sub 4)-pair u, v in an induced K(sub 4)-e. The following result is proved if set N(x) union N(y) is contained in N(u) union N(v) union the set (u,v), then G is Hamiltonian if and only if G + uv is Hamiltonian. As a consquence, a claw free graph G is Hamiltonian if and only if G + uv is Hamiltonian, where u, v is a K(sub 4)-pair. Based on these results so called K(sub 4)-closures of G are defined. Infinite classes of graphs with small maximum degree and large diameter, and with many vertices of degree two having complete K(sub 4)-closures are given. ESA

N91-22807# Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
DUALITY FOR LINEAR SYSTEMS: EXTERNAL AND STATE SPACE CHARACTERIZATION OF THE ADJOINT SYSTEM
A. J. vanderSchaft Nov. 1990 15 p
(Memo-906; ISSN-0169-2690; ETN-91-99143) Avail: NTIS HC/MF A03

After providing an intrinsic definition of the adjoint system of a linear system given in state space form, the adjoint system is characterized in terms of the system's external behavior Conversely it is shown how this external characterization allows one to recover the state space definition by reconstructing an isomorphism from the abstractly defined minimal state space of the system itself. It is shown how a coordinate expression of this isomorphism can be obtained from a modified form of the Bezoutian matrix. ESA

N91-22808# Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
ASYMPTOTICALLY OPTIMAL RANK TESTS FOR MULTI-FACTOR EXPERIMENTAL DESIGN PROBLEMS WITH RESPECT TO A LOCATION PARAMETER AND A SCALE PARAMETER
T. J. Terpstra Nov. 1990 11 p
(Memo-907; ISSN-0169-2690; ETN-91-99144) Avail: NTIS HC/MF A03

An asymptotically optimal rank test for the one factor problem with respect to a location parameter is constructed. Asymptotically optimal rank tests for multifactor experimental design problems with respect to a location parameter and in the case of a scale parameter are considered. The Lehmann class of alternatives generated from the exponential alternative is obtained. ESA

N91-22809# Leiden Univ. (Netherlands). Div. of Applied Mathematics.
THE STABILITY OF A CLASS OF RUNGE-KUTTA METHODS FOR DELAY DIFFERENTIAL EQUATIONS
K. J. intHout Aug. 1990 12 p
(TW-90-05; ETN-91-99146) Avail: NTIS HC/MF A03

The stability analysis of Runge-Kutta methods for delay differential equations are dealt with. The subclass of collocation methods with abscissae in (0,1) is focused upon and it is proved that all of these methods violate an important stability condition related to a given class of test problems. ESA

N91-22810# Leiden Univ. (Netherlands). Div. of Applied Mathematics.
ON A CONJECTURE BY LEVEQUE AND TREFETHEN RELATED TO THE KREISS MATRIX THEOREM
M. N. Spijker Nov. 1990 7 p
(TW-90-07; ETN-91-99148) Avail: NTIS HC/MF A02

In the Kreiss matrix theorem the power boundedness of N x N matrices is related to a resolvent condition on these matrices. LeVeque and Trefethen proved that the ratio of the constants in these two conditions can be bounded by 2eN. They conjectured that this bound can be improved to eN. In this study the conjecture is proved to be true. The proof relies on a lemma which provides an upperbound for the arc length of the image of the unit cirle in the complex plane under a rotational function. This lemma may be of independent interest. ESA

N91-22811# Leiden Univ. (Netherlands). Div. of Applied Mathematics.
ON THE SHORTEST QUEUE POLICY FOR THE TANDEM PARALLEL QUEUE
Arie Hordijk and Ger Koole (North Carolina Univ., Chapel Hill.) 1990 19 p
(TW-90-08; ETN-91-99149) Avail: NTIS HC/MF A03

Two nodes in tandem with parallel queues in each node is considered for the problem of obtaining the stationary distribution under the shortest queuing policy. A policy which stochastically minimizes the number of customers in the system at any time point is studied. A tandem parallel queue with Partial Information (PI) and another case called the Full Information (FI) case where the routing decisions in a node may also depend on the queue lengths at the other node are considered. It is shown that optimal control is threshold policy. ESA

N91-22812# Technische Univ., Eindhoven (Netherlands).
CONTRIBUTION TO THE THEORY OF DISTANCE REGULAR GRAPHS Ph.D. Thesis
Ernst Willem Lambeck 1990 115 p
(ETN-91-99169) Avail: NTIS HC/MF A06

Distance regular graphs are introduced and some examples are given. Objects and terminology are explained. Restrictions on the intersection array of distance regular graphs are obtained. The characterization of distance regular graphs by their parameters is addressed, including the characterization of a dodecahedron. Substructures of a distance regular graph are studied. The existence of Petersen subgraphs in certain distance regular graphs is shown and their existence is used in some uniqueness proofs. The hyperplanes of the regular near hexagon on 759 points is studied. Classical distance regular graphs are adressed: the Hamming, Johnson, Grassman, dual polar, bilinear forms, alternating forms, Hermitian forms and quadratic forms graphs. For these graphs it is shown that 2-convexity usually implies convexity and all convex subgraphs need to be known. It turns out that a convex subgraph C of a graph Gamma is of the same type as Gamma, when Gamma is one of the above mentioned graphs. The only exception is the Hermitian forms which sometimes have one other convex subgraph. ESA

N91-22813# Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
HOW TO SOLVE EXPLICITY A THUE-MAHLER EQUATION
N. Tzanakis (Crete Univ., Iraklion, Greece) and B. M. M. deWeger 14 Nov. 1990 46 p
(Memo-905; ISSN-0169-2690; ETN-91-99218) Avail: NTIS HC/MF A03

A general practical method for solving a Thue-Mahler equation is given. Using algebraic number theory and the theory of linear forms in logarithms of algebraic numbers in both the complex and p-adic case, an explicit upper bound for the solutions is derived. A practical method for a considerable reduction of this bound is presented, based on computational real and p-adic diophantine approximation techniques, in which the main tool is the LLL algorithm. Special attention is paid to the, in general, non trivial problem of finding the solutions below the reduced bound, using an algorithm of Fincke and Pohst for determining lattice points in a given sphere, and a sieving process. As an illustration of the usefulness of the method, a specific Thue-Mahler equation is completely solved. ESA

N91-22814*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A NEW FLUX SPLITTING SCHEME
Meng-Sing Liou and Christopher J. Steffen, Jr. May 1991 33 p
(NASA-TM-104404; E-6227; NAS 1.15:104404) Avail: NTIS HC/MF A03 CSCL 12A

A new flux splitting scheme is proposed. The scheme is remarkably simple and yet its accuracy rivals and in some cases surpasses that of Roe's solver in the Euler and Navier-Stokes solutions performed in this study. The scheme is robust and converges as fast as the Roe splitting. An approximately defined cell-face advection Mach number is proposed using values from the two straddling cells via associated characteristic speeds. This interface Mach number is then used to determine the upwind extrapolation for the convective quantities. Accordingly, the name of the scheme is coined as Advection Upstream Splitting Method (AUSM). A new pressure splitting is introduced which is shown to behave successfully, yielding much smoother results than other existing pressure splittings. Of particular interest is the supersonic blunt body problem in which the Roe scheme gives anomalous solutions. The AUSM produces correct solutions without difficulty for a wide range of flow conditions as well as grids. Author

65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

N91-22815*# National Aeronautics and Space Administration, Washington, DC.
NASA STANDARD: TREND ANALYSIS TECHNIQUES
Oct. 1990 91 p Revised
(NASA-STD-8070.5A; NAS 1.82:8070.5A) Avail: NTIS HC/MF A05 CSCL 12A

Descriptive and analytical techniques for NASA trend analysis applications are presented in this standard. Trend analysis is applicable in all organizational elements of NASA connected with, or supporting, developmental/operational programs. This document should be consulted for any data analysis activity requiring the identification or interpretation of trends. Trend analysis is neither a precise term nor a circumscribed methodology: it generally connotes quantitative analysis of time-series data. For NASA activities, the appropriate and applicable techniques include descriptive and graphical statistics, and the fitting or modeling of data by linear, quadratic, and exponential models. Usually, but not always, the data is time-series in nature. Concepts such as autocorrelation and techniques such as Box-Jenkins time-series analysis would only rarely apply and are not included in this document. The basic ideas needed for qualitative and quantitative assessment of trends along with relevant examples are presented. Author

N91-22816# Stanford Univ., CA. Dept. of Statistics.
SIMULTANEOUS COMPARISONS OF MULTIPLE TREATMENTS TO TWO (OR MORE) CONTROLS

Donald R. Hoover 27 Dec. 1990 18 p
(Contract N00014-89-J-1627)
(AD-A231079; TR-438) Avail: NTIS HC/MF A03 CSCL 12/3

Dunnett (1955) developed a procedure comparing m treatments to one control with an exact overall type one error of alpha when all sampling distributions as normal. Sometimes it is desirable to compare m treatments to K greater than or equal to 2 controls. In particular, it is often desired to compare m treatments with two controls. For instance, several new treatments (e.g., pain relievers) could be compared to two standard treatments (e.g., Aspirin and Tylenol). Alternatively, a standard treatment could be very expensive, difficult to apply and/or have bad side effects, making it useful to compare each new treatment to both standard treatment and no treatment (placebo). Dunnett's method is expanded here to give comparisons of mean values for m treatments to mean values for K greater than or equal to 2 controls at an exact overall type one error of alpha when all sampling distributions are normal. Tabled values needed to make exact simultaneous comparisons at alpha = .05 are given for K = 2. An application is made to an illustrative example for the literature. GRA

N91-22817# Naval Research Lab., Washington, DC.
A PROBABILISTIC MODEL FOR LINK-11 NETWORKING OPERATION
John S. Schlorff 25 Jan. 1991 33 p
(AD-A231801; NRL-MR-6776) Avail: NTIS HC/MF A03 CSCL 12/7

The networking operation of the Link-11 tactical data network is modeled. The model is a Markov chain analysis of the finite state machine that controls the polling sequence in the Link-11 Data Net Control Station. The net cycle time, the effective throughput, and the channel utilization of the network based on modem performance metrics is calculated. The model is based on a number of simplifying assumptions, which include uniform channel conditions for all nodes and a uniform and simplified message generation function for all nodes. The model also assumes that no collisions in transmission can occur. GRA

N91-22818# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
BAYESIAN ESTIMATION FOR DECISION-DIRECTED STOCHASTIC CONTROL Ph.D. Thesis - Technische Hogeschool
H. A. P. Blom 15 Mar. 1990 137 p
(NLR-TP-90039-U; ETN-91-99162) Copyright Avail: NTIS HC/MF A07

Stochastic processes with a decision directed control are considered as controlled Markov processes, the state space of which is hybrid; i.e., a product of a discrete set and Euclidean space. This approach yields a mathematical model for many problems of decision directed stochastic control. In general, the observations made from the 'past' and 'present' Markov state do not lead to a perfect knowledge of the 'present' discrete valued state component. In such situations, the optimal control may be obtained by applying two successive steps: a Bayesian estimation (evaluation of the conditional distribution) of the Markov process, followed by optimal control of the additional distribution on the basis of perfect knowledge of its evolution. Unfortunately, the evaluation of each of these steps implies significant difficulties in case where the Markov state is hybrid. The modeling of hybrid state Markov processes and the solution problems that are associated with the Bayesian estimation of these processes are discussed. ESA

N91-22819# Helsinki Univ. of Technology, Espoo (Finland). Lab. of Computer and Information Science.
TEXTURE CLASSIFICATION AND SEGMENTATION BASED ON NEURAL NETWORK METHODS Ph.D. Thesis
Ari Visa 1990 51 p
(ETN-91-99260) Avail: NTIS HC/MF A04

The problem of automatic texture classification and the development of a method to classify stochastic textures were addressed. Real textures were seldomly found to be homogeneous so the developed method was also tested on segmentation of textured images. The need for a considerable amount of known samples in the classical pattern recognition process is discussed. A simplified process based on neural network methods, self organized topological feature map, and learning vector quantization is presented. ESA

66 SYSTEMS ANALYSIS

Includes mathematical modeling; network analysis; and operations research.

N91-22820# RAND Corp., Santa Monica, CA.
FIRST-STRIKE STABILITY AND STRATEGIC DEFENSES. PART 2: A METHODOLOGY FOR EVALUATING STRATEGIC FORCES
Glenn A. Kent and David E. Thaler Oct. 1990 70 p Sponsored by AF
(AD-A231524; R-3918-AF-Pt-2) Avail: NTIS HC/MF A04 CSCL 15/3

First-strike stability between two adversaries is robust when both leaders perceive no great difference between the expected 'cost' to each side of striking first and the expected 'cost' of incurring a first strike if one withholds his attack. Conclusions include: (1) First-strike stability is currently quite robust. (2) Deployment of strategic nationwide ballistic missile defenses by either superpower in competition with the other's strategic offenses generally erodes first-strike stability. (3) Neither country would be likely to continue to adhere to agreements that constrain and reduce offensive arms under the specter of intent by the other to deploy robust strategic defenses in contravention to the 1972 Anti-Ballistic Missile (ABM) Treaty. (4) There may be a 'window' in which United States and Soviet strategic nationwide BMD could be robust in defending against 'limited' attacks (third-country ballistic missile attacks, unauthorized attacks, and accidental launches), yet not so robust that first-strike stability is seriously undermined. (5) The level of U.S. defenses attributed to the so-called 'Phase I' deployment seems to go beyond the upper bounds of this 'window' even with current offensive forces, and certainly with offensive forces constrained by START I. (6) Any attempt to transition to a situation in which each side's strategic defenses dominate the opponent's ballistic missiles must include a careful negotiation on the critical role of bomber forces. GRA

N91-22821# Norwegian Defence Research Establishment, Kjeller.
ALARM RESPONSE OF 'CAM' DOWNWIND TO CHEMICAL ATTACKS
Per B. Storeboe and Tor Bjorvatten 20 Sep. 1990 25 p
(FFI-90/6007; ISSN-0802-2437; ETN-91-99264) Avail: NTIS HC/MF A03

The British CAM (Chemical Agent Monitor) detector may be used as a warning device for chemical attacks. The response to chemical agents in the air was examined, and a simplified working mechanism was assumed. A defence position some 200 m across was examined. Chemical attacks were simulated to the windward side of the position, which had 1, 3 or 7 detectors deployed in an operationally correct manner. The detector response to the clouds drifting in was studied. The concentration time profile at the detector site should be fairly realistic for a war situation of the kind, and the results should be operationally valid. Ample warning time was given when one detector only was working. No significant difference was found between CAM and NAIAD in the respect. ESA

N91-22822# Los Alamos National Lab., NM.
SBI ALLOCATION BETWEEN HEAVY AND SINGLET MISSILES
G. H. Canavan Apr. 1991 9 p
(Contract W-7405-eng-36)
(DE91-009859; LA-11888-MS) Avail: NTIS HC/MF A02

The optimal allocation of space-based interceptors (SBIs) between fixed, heavy missiles and mobile singlets can be derived

from approximate expressions for the boost-phase penetration of each. Singlets can cluster before launch and have shorter burn times, which reduce their availability to SBIs by an order of magnitude. Singlet penetration decreased slowly with the number of SBIs allocated to them; heavy missile penetration falls rapidly. The allocation to the heavy missiles falls linearly with their number. The penetration of heavy and singlet missiles is proportional to their numbers and inversely proportional to their availability.
DOE

N91-22267*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
OPERATIONS ENGINEERING: TIME FOR A NEW PARADIGM
Esker K. Davis and William N. Jensen *In* ESA, Ground Data Systems for Spacecraft Control Oct. 1990 p 489-492 Sponsored by NASA, Washington (For primary document see N91-22189 14-17)
Copyright Avail: NTIS HC/MF A99 CSCL 12B

67 THEORETICAL MATHEMATICS

Includes topology and number theory.

No abstracts in this category.

70 PHYSICS (GENERAL)

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

N91-22823# National Inst. of Standards and Technology, Gaithersburg, MD.
REPORT OF THE 75TH NATIONAL CONFERENCE ON WEIGHTS AND MEASUREMENTS
Albert D. Tholen, ed., Carroll S. Brickenkamp, ed., and Ann H. Turner, ed. Sep. 1990 245 p Conference held in Washington, DC, 9-13 Jul. 1990
(PB91-112763; NIST/SP-793; LC-26-27766) Avail: NTIS HC/MF A11; SOD HC $7.00 as 003-003-03044-9 CSCL 20C

The report of the National Conference on Weights and Measures (NCWM) is presented. The theme of the meeting was 'Progress Through Consensus Among Consumers, Regulators, and Industry.' The following subject areas were covered: progress made by NCWM in the past year; a history of the founding of the National Bureau of Standards and th NCWM; standards for equipment and sales practices in the area of cash/credit pricing of retail motor fuel and compressed gas cylinders; training program development; and standards for moisture loss. Author

N91-22824*# Massachusetts Inst. of Tech., Cambridge. Plasma Fusion Center.
MIT ASTROMAG 1.7 METER DISK MAGNET DESIGN REPORT
P. G. Marston, J. R. Hale, R. Vieira, A. Zhukovsky, P. H. Titus, J. D. Sullivan, and A. M. Dawson Jan. 1990 71 p
(Grant NAG5-1106)
(NASA-CR-187931; NAS 1.26:187931; PFC/RR-91-2) Avail: NTIS HC/MF A04 CSCL 20C

MIT has proposed a magnet design for ASTROMAG, which has demonstrated substantial improvement in performance as compared with the present HEAO baseline design. Several advantages of the MIT disk design are listed along with design characteristics. Details of field contours and active field regions are shown along with comparisons with other designs. Three alternative design configurations for the ASTROMAG disk coils are summarized. The parameters of the conductors are listed and basic parameters for each of the complete systems are shown.
Author

N91-22825# Delaware State Coll., Dover. Dept. of Physics and Astronomy.
ADVANCED STUDY INSTITUTE ON THE SCIENCE AND TECHNOLOGY OF NANOSTRUCTURED MAGNETIC MATERIALS Final Report, 25 Jun. - 6 Jul. 1990
Larry R. Cooper 21 Feb. 1991 19 p
(Contracts N00014-90-G-0756; N00014-90-J-1756)
(AD-A231764) Avail: NTIS HC/MF A03 CSCL 09/1

The Institute reviewed the remarkable progress made in magnetic materials over the last few years and addressed the current state-of-the-art research and its impact on technological applications. The subject matter fell into a number of broad areas including thin films, multilayers, disordered systems, ultrafine particles, intermetallic compounds, permanent magnets and magnetic imaging techniques. The development of new techniques for materials preparation has made a dramatic impact in the area of epitaxial growth of magnetic films. Several presentations have shown that this process can be controlled on the scale of atomic layers permitting the growth of artificial structures such as artificial superlattices with nearly atomic resolution. Epitaxial growth has also permitted stabilization of metastable phases in thin films which often possess a strong perpendicular anisotropy. GRA

N91-22826# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
SIMPLE WZW CURRENTS
Juergen Fuchs Aug. 1990 14 p
(NIKHEF-H/90-14; ETN-91-99128) Avail: NTIS HC/MF A03

A complete classification of simple currents of WZW theories is obtained. The proof is based on an analysis of the quantum dimensions of the primary fields. Simple currents are precisely the primaries with unit quantum dimension; for WZW theories explicit formulae for the quantum dimensions can be derived so that an identification of the fields with unit quantum dimension is possible. ESA

N91-22827# Massachusetts Inst. of Tech., Cambridge. Plasma Fusion Center.
SOLDESIGN USER'S MANUAL
R. D. Pillsbury, Jr. Feb. 1991 47 p
(Contracts DE-AC02-78ET-51013; DE-FG02-91ER-54110; DE-AC22-84PC-70512; DE-AT01-76ET-10813)
(DE91-009795; DOE/ET-51013/T238; PFC/RR-91-3) Copyright Avail: NTIS HC/MF A03

SOLDESIGN is a general purpose program for calculating and plotting magnetic fields, Lorentz body forces, resistances and inductances for a system of coaxial uniform current density solenoidal elements. The program was originally written in 1980 and has been evolving ever since. SOLDESIGN can be used with either interactive (terminal) or file input. Output can be to the terminal or to a file. All input is free-field with comma or space separators. SOLDESIGN contains an interactive help feature that allows the user to examine documentation while executing the program. Input to the program consists of a sequence of word commands and numeric data. Initially, the geometry of the elements or coils is defined by specifying either the coordinates of one corner of the coil or the coil centroid, a symmetry parameter to allow certain reflections of the coil (e.g., a split pair), the radial and axial builds, and either the overall current density or the total ampere-turns (NI). A more general quadrilateral element is also available. If inductances or resistances are desired, the number of turns must be specified. Field, force, and inductance calculations also require the number of radial current sheets (or integration points). Work is underway to extend the field, force, and, possibly, inductances to non-coaxial solenoidal elements. DOE

71 ACOUSTICS

Includes sound generation, transmission and attenuation. For noise pollution see *45 Environmental Pollution.*

N91-22828# Materials Research Labs., Ascot Vale (Australia).
ESTIMATION OF THE ACOUSTIC REFLECTION CHARACTERISTICS OF A PLANE SURFACE HAVING A PERIODIC, SPATIALLY-VARYING SURFACE ADMITTANCE
C. I. Sach Mar. 1991 19 p Sponsored by Royal Australian Navy
(MRL-TN-581; AR-006-333) Avail: NTIS HC/MF A03

A possible technique for studying the acoustic reflection from continuous plane surfaces such as flat plates covered with thin anechoic coatings is discussed. It is particularly directed to complex coatings which include a regular array of non-homogeneous inclusions within their structures. The method involves the experimental determination of a position-dependent quantity which can be viewed as either a surface transfer admittance or a surface transfer mobility function. This function can then be used in a mathematical convolution procedure to determine the nature of the reflected wave from surface when it is ensonified by an incident uniform plane wave arriving in a direction normal to the plate surface. The basic elements of an experimental system for measuring the surface admittance function are discussed.
Author

N91-22829# Naval Research Lab., Orlando, FL. Underwater Sound Reference Detachment.
VARIABLE PROJECTION METHODS WITH APPLICATION TO SUMS OF EXPONENTIALS IN WHITE NOISE Final Report
P. L. Ainsleigh and J. D. George (Signalmetrics, Inc., Winter Park, FL.) 27 Dec. 1990 115 p
(AD-A231344; NRL-MR-6643) Avail: NTIS HC/MF A06 CSCL 20/1

Nonlinear Least-Squares (NLS) methods were examined for estimating the pole and amplitude parameters for a sum of damped and undamped sinusoids observed in white noise. A special case of NLS, which takes advantage of the semilinear structure of this signal model, involves minimization of the Variable Projection Functional (VPF). The VPF offers computational efficiency by providing a means of estimating the signal poles independently of the amplitudes. The existing set of algorithms was extended for optimizing the VPF by deriving the exact Hessian matrix and introducing a Newton algorithm based on the exact Hessian. Algorithms were also developed for optimizing the prediction filter VPF, which is a special case of VPF especially suited for estimating the parameters of sums of exponentials, and introduce methods for constraining each error functional to contain known signal poles. In addition, detailed background material was provided covering computational linear algebra, optimization, and variable projection theory.
GRA

N91-22830*# Tech-U-Fit Corp., Alexandria, VA.
DESIGN METHODOLOGY FOR A COMMUNITY RESPONSE QUESTIONNAIRE ON SONIC BOOM EXPOSURE Final Report
John E. Farbry, Jr., James M. Fields, John A. Molino, and Gwendolyn A. deMiranda May 1991 86 p Prepared in cooperation with Wyle Labs., Inc., Hampton, VA; and Douglas Aircraft Co., Inc., St. Louis, MO
(Contract NAS1-19060)
(NASA-CR-187503; NAS 1.26:187503; TUF-90-07) Avail: NTIS HC/MF A05 CSCL 20A

A preliminary draft questionnaire concerning community response to sonic booms was developed. Interviews were conducted in two communities that had experienced supersonic overflights of the SR-71 airplane for several years. Even though the overflights had ceased about 6 months prior to the interviews, people clearly remembered hearing sonic booms. A total of 22 people living in central Utah and 23 people living along Idaho/Washington state border took part in these interviews. The draft questionnaire was constantly modified during the study in order to evaluate different versions. Questions were developed which related to annoyance, startle, sleep disturbance, building vibration, and building damage. Based on the data collected, a proposed community response survey response instrument was developed for application in a full-scale sonic boom study.
Author

N91-23023*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
VIRTUAL ACOUSTICS DISPLAYS
Elizabeth M. Wenzel, Scott S. Fisher, Philip K. Stone, and Scott H. Foster (Crystal River Engineering, Groveland, Ca.) *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 10-20 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 20A

72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure, electron properties, and molecular spectra.

N91-22831# California Univ., Santa Barbara. Dept. of Physics.
EXACT THEORY OF LONG-WAVELENGTH ONE-PHONON AMPLITUDES IN ATOM-SURFACE SCATTERING
M. Flatte and W. Kohn 18 Feb. 1991 18 p
(Contract N00014-89-J-1530)
(AD-A231661; TR-33) Avail: NTIS HC/MF A03 CSCL 20/12

An expression is derived for the probability of creating or annihilating one long-wavelength surface or bulk phonon during a scattering event, which depends on the bulk elastic constants but is independent of the details of the atom-target potential and of force constant changes near the surface. This expression is exact if the inelastic scattering is weak (the meaning of which is explained in the text). This theory should be experimentally verifiable, e.g. for 20 meV He atoms scattered from a W-surface.
GRA

N91-22832# George Washington Univ., Washington, DC. Dept. of Chemistry.
THE PAST, PRESENT, AND FUTURE OF AUGER LINESHAPE ANALYSIS
David E. Ramaker Jan. 1991 169 p
(Contract N00014-89-J-1103)
(AD-A231676; TR-55) Avail: NTIS HC/MF A08 CSCL 14/2

This review critically evaluates the suitability of Auger spectral line shape analysis as a source of electronic structure information. Methods for extracting the true Auger line shape from the raw data and a theoretical framework for semiquantitative interpretation of that line shape are presented. A wide range of recent applications, concentrating on the line shapes of the low Z metals (Be, Li, Na, Mg, and Al), the line shapes of C and Si, the transition metals, and finally, those of the metal oxides and halides, are considered. Spectra for gas phase molecules, absorbed molecules, and solids are examined. Finally, new methods for controlling the background, the initial state, the spin polarization, and the angle of escape are discussed along with requirements for improving the theory. Over 350 references are included.
GRA

N91-22833# Wisconsin Univ., Madison. Dept. of Physics.
INELASTIC COLLISIONAL PROCESSES OF MOLECULES Final Report, 1 Nov. 1988 - 30 Apr. 1990
30 Apr. 1990 20 p
(Grant AF-AFOSR-0006-89; AF Proj. 2301)
(AD-A231898; AFOSR-91-0031TR) Avail: NTIS HC/MF A03 CSCL 20/5

Absolute apparent cross sections for electron-impact excitation out of the 2-triplet-S metastable level of He to the 3-triplet-S, 4-triplet-S, 3-triplet-P, 3-triplet-D, 5-triplet-D, and 6-triplet-D levels have been measured by a novel method. A beam of metastable atoms from a hollow-cathode discharge was crossed by an electron beam of energy from 3 to 16 eV, and the emission from the excited states was detected. Absolute calibration was made by measuring the ratio of electron excitation cross section to the known optical absorption cross section and using knowledge of

the pertinent branching ratios. Direct electron-impact excitation cross sections for the 3-triplet-P, 3-triplet-S, and 3-triplet-D, levels were obtained. GRA

N91-22834# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
FINITE ELEMENT CALCULATIONS ON REAR CALORIMETERMODULES FOR THE ZEUS EXPERIMENT
R. Blankers 1 Jul. 1990 45 p
(NIKHEF-H/90-10; ETN-91-99125) Avail: NTIS HC/MF A03

Results of a series of finite element calculations on the rear calorimeter modules of the Zeus detector to study electron proton collisions at the HERA storage ring at Desy, Hamburg (Germany, F.R.) are described. The main motivation is to find out where in the module the maximum forces and stresses occur under different boundary and load conditions. The module is described and finite element methods introduced. The calculated load cases and resulting forces and stresses are described. ESA

N91-22835# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
THE SPHALERON AT FINITE MIXING ANGLE
F. R. Klinkhamer and R. Laterveer 1990 16 p Sponsored by Royal Netherlands Academy of Arts and Sciences
(NIKHEF-H/90-12; ETN-91-99127) Avail: NTIS HC/MF A03

The exact Sphaleron solution in the bosonic sector of the electroweak standard model is only known for weak mixing angle, theta(sub W) = 0. To investigate the behavior closer to the experimental value theta(sub W) (to the exponential) is approximately equal to 30, a noncontractible loop in configuration space which is sensitive to theta(sub W) was constructed. The numerical results for the energy and the magnetic dipole moment indicate that the dependence on theta(sub W) is rather weak. ESA

N91-22836# Iowa State Univ. of Science and Technology, Ames.
INCLUSIVE D*(+,-) PRODUCTION IN PHOTON-PHOTON COLLISIONS
M. Alston-Garnjost, R. E. Avery, A. R. Barker, D. A. Bauer, A. Bay, A. Buijs, R. Belcinski, H. H. Bingham, E. D. Bloom, and C. D. Buchanan (California Univ., Los Angeles.) Amsterdam, Netherlands Nationaal Instituut voor Kernfysica en Hoge-Energiefysica Oct. 1990 16 p Sponsored in cooperation with NSF, and Stichting voor Fundamenteel Onderzoek der Materie
(Contracts W-7405-eng-82; DE-AT03-89ER-40492; DE-AS03-76ER-70285; DE-AT03-88ER-40384; DE-AT03-87ER-40327)
(NIKHEF-H/90-16; SU-SLAC-PUB-5348; ETN-91-99130) Avail: NTIS HC/MF A03

The TPC/two-gamma collaboration measured the inclusive cross section for production of charmed D*(+,-) mesons in photon-photon collisions. The reaction utilized was e+e- onto e+e-D*(+,-)X, with D*(+,-) onto D(0)pi(+,-), D(0) onto K(-,+)pi(+,-), and either zero or one outgoing e(+,-) detected. The result, e+e- onto e+e-D*(+,-)X = 74 + or - 26 + or - 19 pb, is in agreement with the quark parton model prediction for e+e- onto e+e-ccbar, combined with a Lund model for the hadronization of the charmed quarks. ESA

N91-22837# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
QCD RADIATIVE CORRECTIONS TO CHARGED CURRENT HEAVY QUARK PRODUCTION
J. J. vanderBij (Amsterdam Univ., Netherlands) and G. J. vanOldenborgh Nov. 1990 19 p
(NIKHEF-H/90-19; ETN-91-99132) Avail: NTIS HC/MF A03

The quantum chromodynamics (QCD) radiative corrections to charged current heavy quark production are given in the limit that the weak partner is massless, i.e. using a bottom structure function for top quark production. The results for charm production in neutrino nucleon scattering agree with those published before, but this method enables us to study all outgoing paticles. The corrections to top production at the proposed large electron positron/large hadron collider (LEP/LHC) electron-proton collider are discussed. ESA

N91-22838# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
SPHALERONS AND ENERGY BARRIERS IN THE WEINBERG-SALAM THEORY
F. R. Klinkhamer Oct. 1990 8 p Presented at 25th International Conference on High Energy Physics, Singapore, 2-8 Aug. 1990 Submitted for publication Sponsored by Royal Netherlands Academy of Arts and Sciences
(NIKHEF-H/90-20; ETN-91-99133) Avail: NTIS HC/MF A02

Some recent results regarding nontrivial structure in the configuration space of the electroweak standard model and related classical solutions (sphalerons) are presented. It is found that the Sphaleron does not change much as the mixing angle is increased from O to pi/6. At very large Higgs mass the Sphaleron acquires more than one negative mode and other solutions ('deformed sphalerons') appear. The reason for this is given. It is concluded that more and more structure in configuration space appears at higher and higher energies and truly nonperturbative understanding (not just saddle point approximations) of Young-Mills-Higgs theory seems to be required. ESA

N91-22839# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
THE ALPHA CUBED SUB S CORRECTIONS TO THE BJORKEN SUM RULE FOR POLARIZED ELECTROPRODUCTION AND TO THE GROSS-LLEWELLYN SMITH SUM RULE
S. A. Larin (Academy of Sciences, USSR, Moscow) and J. A. M. Vermaseren 1990 15 p
(NIKHEF-H/90-23; ETN-91-99134) Avail: NTIS HC/MF A03

The next-next-to-leading order quantum chromodynamics (QCD) corrections to the Gross-Llewellyn Smith sum rule for deep inelastic neutrino-nucleon scattering was computed. This involved the proper treatment of gamma 5 inside the loop integrals within dimensional regularization. It was found that the difference between the two sum rules are entirely due to a class of six three loop graphs and is of the order of one percent of the leading QCD term. Hence, the Q squared behavior of both sum rules should be nearly the same if the physics is described adequately by the lower order terms of the perturbative QCD. ESA

N91-22840# Keuring van Electrotechnische Materialen N.V., Arnhem (Netherlands). Dept. of Chemical Technology and Material Research.
EXPERIMENTS ON THE HIGH-TEMPERATURE BEHAVIOUR OF NEUTRON-IRRADIATED URANIUM DIOXIDE AND FISSION PRODUCTS, VOLUME 8, NUMBER 1
R. H. J. Tanke 1990 82 p Revised
(ST-Rept-Vol-8-No-1; ISBN-90-353-0078-5; ISSN-0167-8590; ETN-91-99160) Copyright Avail: NTIS HC/MF A05

The release rate of fission products from overheated UO2, the chemical form of these fission products, and the transport mechanism inside the nuclear fuel are determined. UO spheres of approximately 1 mm diameter, irradiated in a high-flux reactor were used for the experiments. The chemical forms of the particles released from the spheres during evaporation were determined by mass spectrometry and the release rate of the mission products was determined by gamma spectrometry. A gamma topographer was developed to determine the change with temperature in the three dimensional distribution of radioactive fission products in the spheres. No clear relationship between the stoichiometry of the spheres and uranium consumption were shown. A diffusion model was used to determine the activation energy for the diffusion of fission products. It is concluded that the microstructure of the nuclear fuel greatly affects the number of free oxygen atoms, the release rate and the chemical form of the fission products. The evaporation of the UO2 matrix is the main mechanism for the release of all fission products at temperatures above 2300 K.

Barium can be as volatile as iodine. Niobium and lanthenum can be volatile. Molecular combinations of the fission products, iodine, cesium and tellurium, are highly unlikely to be present inside the fuel. Barium and nobium may form compounds with oxygen and are then released as simple oxides. Fission products are released from overheated UO2 or as oxides. A new model is proposed for describing the behavior of oxygen in irradiated nuclear fuel. ESA

N91-22841# Technische Univ., Eindhoven (Netherlands).
BUILD-UP AND RELAXATION OF MOLECULAR ORIENTATION IN INJECTION MOULDING Ph.D. Thesis
Antonius Adrianus Ma Flaman 1990 223 p
(ETN-91-99176) Avail: NTIS HC/MF A10

A numerical simulation model for the analysis of the building up and the relaxation of molecular orientation during the manufacture of injection molded products in order to understand the mechanism and to develop methods to reduce the frozen-in orientation is developed. Attention is focused on thermoplastic materials and simple geometries. The constitutive equations of the material are described using an extended version of the viscoelastic material model developed by Leonov and are coupled with the conservation laws, resulting in a set of nonlinear coupled partial differential equations which are solved using a finite element method. The method can be used to optimize the processing conditions and the geometry of the insulation layer together with a heat flux profile to mold high quality products with minimum frozen in orientation. The application of a heater minimizes the frozen in birefrigence at the wall while a prescribed packing pressure profile minimizes the level of the intermediate zone. ESA

N91-22842# Technische Univ., Eindhoven (Netherlands).
TRANSPORT OF HOT ELECTRONS IN GaAs/AlGaAs HETEROSTRUCTURES Ph.D. Thesis
Peter Hendriks 14 Dec. 1990 94 p Sponsored by Netherlands Organization for the Advancement of Pure Research
(ETN-91-99177) Avail: NTIS HC/MF A05

Aspects important for the performance of a High Electron Mobility Transistor (HEMT) are discussed. Since HEMTs use gate electrodes, the lateral fields depend on position. This problem must be solved self consistently using the three dimensional Schroedinger and Poisson equations. Two-terminal devices are used to gain insight into the physical mechanisms governing the hot electron transport. Several techniques are developed to image the electric field, voltage and resistivity as a function of position in order to investigate the homogeneity of the two dimensional electron gas. The use of liquid crystals to reveal regions where high electric fields are present is described and it is concluded that effects originally thought to be contact problems can originate from the properties of the two dimensional electron gas. Scanning Electron Microscope (SEM) voltage contrast and the eletrooptic effect of the GaAs substrate are used to image the potential distribution. The Optical Beam Induced Current (OBIC) technique was used to determine the homogeneity of the ohmic contacts on heterostructures. The transitional area from contact to heterostructure is shown to be of extreme importance in understanding the device behavior. Within the model it is possible to understand the oscillatory behavior found in some heterostructures in high electric fields. ESA

N91-22843# Technische Univ., Eindhoven (Netherlands).
HIGH-RESOLUTION LOW-ENERGY ELECTRON DIFFRACTION Ph.D. Thesis
Albert Gerrit Roosenbrand 16 Nov. 1990 137 p
(ETN-91-99185) Avail: NTIS HC/MF A07

The basics and applications of HR-LEED (High Resolution-Low Energy Electron Diffraction), an experimental technique to obtain qualitative and quantitative information on the morphology of single crystal surfaces, are discussed. By using HR-LEED the morphological characteristics can be obtained on a length scale ranging from interatomic distances up to several hundreds of nanometers. The kinematic theory of HR-LEED is reviewed and some instrumental aspects of the setup are discussed. A comparative study between HR-LEED and the Scanning Tunneling Microscope (STM) is presented. HR-LEED experiments on epitaxially grown GaAs (001) surfaces are described. Interesting sputter phenomena and the surface morphology of the arsenic rich (1 by 1) GaAs (001) surface are discussed. The diffraction features as observed in the transition region between the two arsenic rich (1 by 1) and (2 by 4) surfaces are described. ESA

N91-22844# Stockholm Univ. (Sweden). Inst. of Physics.
THE TRANSVERSE MOMENTUM OF HADRONS IN LEPTO-PRODUCTION AS A TEST OF QCD
M. Berggren Sep. 1990 51 p
(USIP-90-04; ETN-91-99243) Avail: NTIS HC/MF A04

A method to calculate the average of a smeared stochastic variable is presented, for the case where the moments of the variable are known, as well as the distribution of a smearing. It is applied to the algebraic moments of the transverse momentum distribution of the hadrons emerging from the current fragmentation region in lepto production. The derivation of the prediction uses the QCD (Quantum Chromodynamics) formulae for the moments of the transverse momentum distribution of the partons giving rise to the observed hadrons in the forward region. It is indicated how QCD can be tested by studying the Q(2), W and multiplicity dependence of the hadronic transverse momenta, and in particular how to determine Lambda(QCD). ESA

N91-22845# Stockholm Univ. (Sweden). Inst. of Physics.
A DETERMINATION OF ALPHA(s) FROM THE TRANSVERSE MOMENTA OF HADRONS PRODUCED IN NEUTRINO AND ANTINEUTRINO INTERACTIONS
M. Bergren, J. Guy, P.-O. Hulth, G. T. Jones, U. F. Katz, P. Marage, E. Matsinos, S. W. ONeale, E. Simopoulou, and K. E. Varell (Birmingham Univ., England) et al Oct. 1990 32 p Submitted for publication
(USIP-90-07; ETN-91-99244) Avail: NTIS HC/MF A03

The W and Q(2) dependence of the transverse momentum of the forward going hadrons in deep inelastic neutrino charged current interactions on neon is studied. The data were obtained by exposing the Big European Bubble Chamber (BEBC) filled with an Ne/He mixture to the CERN SPS wideband neutrino beam. The data on average transverse momentum are compared to a model which includes first order quantum chromodynamics, intrinsic quark momentum in the nucleon and Fermi motion, as well as a simple model hadronization. The model describes the data well. ESA

N91-22846*# Houston Univ., TX. Dept. of Chemistry.
THEORETICAL STUDIES OF MOLECULAR COLLISIONS Final Report
Donald J. Kouri 1991 10 p
(Grant NAG2-503)
(NASA-CR-188190; NAS 1.26:188190) Avail: NTIS HC/MF A02 CSCL 20H

The following subject areas are covered: (1) total integral reactive cross sections and vibrationally resolved reaction probabilities for F + H2 = HF + H; (2) a theoretical study of inelastic O + N2 collisions; (3) body frame close coupling wave packet approach to gas phase atom-rigit rotor inelastic collisions; (4) wave packet study of gas phase atom-rigit motor scattering; (5) the application of optical potentials for reactive scattering; (6) time dependent, three dimensional body frame quantal wave packet treatment of the H + H2 exchange reaction; (7) a time dependent wave packet approach to atom-diatom reactive collision probabilities; (8) time dependent wave packet for the complete determination of s-matrix elements for reactive molecular collisions in three dimensions; (9) a comparison of three time dependent wave packet methods for calculating electron-atom elastic scattering cross sections; and (10) a numerically exact full wave packet approach to molecule-surface scattering. Author

N91-22847# Wisconsin Univ., Madison.
SPECTROSCOPY, REACTION, AND PHOTODISSOCIATION OF HIGHLY VIBRATIONALLY EXCITED MOLECULES

F. F. Crim 1990 4 p
(Contract DE-FG02-86ER-13500)
(DE91-008840; DOE/ER-13500/T2) Avail: NTIS HC/MF A01

This research is designed to determine the nature of highly vibrationally excited molecules, probe unimolecular reactions at the level of individual quantum states, and study the dynamics of electronic photodissociation from highly vibrationally excited states. In our experiments, pulsed laser excitation of a vibrational overtone transition prepares a highly vibrationally excited molecule and time-resolved spectroscopic detection of products monitors their subsequent decomposition. We have used this scheme to follow unimolecular reactions of large and small molecules in both room temperature gases and supersonic expansions and to investigate the role that vibrational excitation plays in electronic photodissociation dynamics. Most recently we have used the localized nature of the highly vibrationally excited states we create to selectively break bonds in photodissociation and biomolecular reactions. DOE

N91-22848# Texas Univ., Houston. Dept. of Physics.
SELECTED PROBLEMS IN EXPERIMENTAL INTERMEDIATE ENERGY PHYSICS
B. W. Mayes, E. V. Hungerford, and L. S. Pinsky Sep. 1990 62 p
(Contract DE-FG05-88ER-40419)
(DE91-008910; DOE/ER-40419/22) Avail: NTIS HC/MF A04

This report discusses progress in the following areas of intermediate energy physics; hyperon physics at the AGS; electroproduction of hypernuclei; test of the standard model of electroweak interactions; and spin structure function of the neutron. DOE

N91-22849# Los Alamos National Lab., NM.
COUPLED PROTON/NEUTRON TRANSPORT CALCULATIONS USING THE S(SUB N) AND MONTE CARLO METHODS
W. L. Filippone (Arizona Univ., Tucson.), R. C. Little, J. E. Morel, R. E. MacFarlane, and P. G. Young 1991 11 p Presented at the International Topical Meeting on Advances in Mathematics, Computation and Reactor Physics, Pittsburgh, 28 Apr. - 2 May 1991
(Contract W-7405-eng-36)
(DE91-009949; LA-UR-91-863; CONF-910414-26) Avail: NTIS HC/MF A03

Coupled charged/neutral particle transport calculations are most often carried out using the Monte Carol technique. For example, the ITS, EGS, and MCNP (Version 4) codes are used extensively for electron/photon transport calculations while HETC models the transport of protons, neutrons and heavy ions. In recent years there has been considerable progress in deterministic models of electron transport, and many of these models are applicable to protons. However, even with these new models (and the well established models for neutron transport) deterministic coupled neutron/proton transport calculations have not been feasible for most problems of interest, due to a lack of coupled multigroup neutron/proton cross section sets. Such cross sections sets are now being developed at Los Alamos. Using these cross sections we have carried out coupled proton/neutron transport calculations using both the S(sub N) and Monte Carlo methods. The S(sub N) calculations used a code called SMARTEPANTS (simulating many accumulative Rutherford trajectories, electron, proton and neutral transport solver) while the Monte Carlo calculations are done with the multigroup option of the MCNP code. Both SMARTEPANTS and MCNP require standard multigroup cross section libraries. HETC on the other hand, avoids the need for precalculated nuclear cross sections by modeling individual nucleon collisions as the transporting neutrons and protons interact with nuclei. DOE

N91-22850# Oak Ridge National Lab., TN.
ELECTRON CORRELATION EXPLORED THROUGH ELECTRON SPECTROMETRY USING SYNCHROTRON RADIATION
C. D. Caldwell, S. B. Whitfield, M. G. Flemming (University of Central Florida, Orlando.), and M. O. Krause 1991 9 p Presented at the 3rd US/Mexico Atomic and Molecular Physics Workshop, Mexico City, Mexico, 13-16 Mar. 1991
(Contract DE-AC05-84OR-21400)
(DE91-009917; CONF-9103146-1) Avail: NTIS HC/MF A02

The development of synchrotron radiation facilities as a research tool has made possible experiments which provide new insights into the role which correlation plays in electron dynamics and atomic and molecular structure. Features such as autoionizing resonances, normal and resonant Auger decay modes, and ionization threshold structure have become visible in a wealth of new detail. Some aspects of this information drawn from recent experiments on the alkaline earth metals and the rare gases are presented. The potential for increased flux and resolution inherent in insertion device-based facilities like the Advanced Light Source should advance this understanding even further, and some future directions are suggested. DOE

73 NUCLEAR AND HIGH-ENERGY PHYSICS

Includes elementary and nuclear particles; and reactor theory.

For space radiation see *93 Space Radiation.*

N91-22851# Brookhaven National Lab., Upton, NY.
THE GRATING AS AN ACCELERATING STRUCTURE
R. C. Fernow Feb. 1991 45 p
(Contract DE-AC02-76CH-00016)
(DE91-010297; BNL-52285) Avail: NTIS HC/MF A03

This report considers the use of a diffraction grating as an accelerating structure for charged particle beams. We examine the functional dependence of the electromagnetic fields above the surface of a grating. Calculations are made of the strength of the accelerating modes for structures with (pi) and 2(pi) phase advance per period and for incident waves polarized with either the E or H vector along the grooves of the grating. We consider examples of using gratings in a laser linac and in a grating lens. We also briefly examine previous results published about this subject. DOE

N91-22852# University of Northern Illinois, De Kalb.
STUDIES OF HIGH ENERGY PHENOMENA USING MUONS
1990 13 p
(Contract DE-AC02-87ER-40368)
(DE91-010397; DOE/ER-40368/T1) Avail: NTIS HC/MF A03

This report covers the activities of the NIU high energy physics group as supported by DOE contract AC02-87ER40368 during the period from March through December of 1990. The group has two primary efforts. The first is the D0 experiment at the Fermilab proton-antiproton collider, with major emphasis on its muon system. The second is the involvement of a portion of the group in Fermilab Experiments 772 and 789. Finally, there is participation in the design of detectors for the SSC. A more detailed description of the work of the NIU high energy physics group may be found in the narrative accompanying the contract renewal proposal. DOE

N91-22853# Texas Univ., Austin. Fusion Research Center.
EFFECT OF BEAM-ATTENUATION MODULATION ON FLUCTUATION MEASUREMENTS BY HEAVY-ION BEAM PROBE
D. W. Ross, M. L. Sloan, A. J. Wootton, P. M. Schoch, J. W. Heard, T. P. Crowley, R. L. Hickok, and V. Simcic Mar. 1991 33 p Prepared in cooperation with Rensselaer Polytechnic Inst., Troy, NY
(Contracts DE-FG05-88ER-53266; DE-FG05-88ER-53267)
(DE91-010423; DOE/ER-53266/35; FRCR-380) Avail: NTIS HC/MF A03

Beam-attenuation modulation arising from density fluctuations along the orbit of the heavy-ion beam probe can distort the local amplitude, coherence, and phase derived from one- and two-point correlation measurements. Path-integral expressions for these effects are derived and applications to TEXT data are discussed.

The effects depend critically on the ratio of the average fluctuation amplitude along the beam path to the local average fluctuation amplitude the sample volume. Because the fluctuation amplitude is small in the core and rises sharply toward the plasma edge, the contamination effect is negligible in a radial zone near the edge but rises sharply to the interior of a critical radius. With increasing average plasma density the interior contamination increases strongly and the critical radius moves outward. DOE

N91-22144*# Brookhaven National Lab., Upton, NY.
ULTRA HIGH TEMPERATURE PARTICLE BED REACTOR DESIGN
Otto Lazareth, Hans Ludewig, K. Perkins, and J. Powell *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 107-113 (For primary document see N91-22139 14-12)
(Contract DE-AC02-76CH-00016)
Avail: NTIS HC/MF A25 CSCL 18I

74 OPTICS

Includes light phenomena; and optical devices.
For lasers see *36 Lasers and Masers.*

N91-22854# Army Natick Labs., MA.
A CORRELATION STUDY BETWEEN TWO COLOR-MEASURING SPECTROPHOTOMETERS Final Report, Feb. - Sep. 1990
Robin R. St.Pere Jan. 1991 49 p
(AD-A231416; NATICK/TR-91/012) Avail: NTIS HC/MF A03 CSCL 11/5

The U.S. Army recently completed a four phase effort to develop an objective computerized method for evaluating shade acceptability of dyed and printed textiles for the government quality assurance program. Rapidly emerging developments in the field of optics and computers have made older instruments obsolete. This study evaluates the repeatability and correlation between two spectrophotometers manufactured 8 years apart by Applied Color Systems of Princeton, New Jersey. The samples (20 fabric swatches, 22 porcelain tiles, and a color difference pair) were measured for short- and long-term repeatability. Each instrument was found to show a repeatability of 0.12 CIELAB color difference units or less for the two time periods studied. The largest color difference observed between the two instruments for these samples was 0.5 CIELAB color difference units. The color difference pair correlation measurements and repeatability of the instruments data were very good. Measurements in the infrared region (up to 900 nm) for the two instruments demonstrated very good repeatability and correlation results. GRA

N91-22855# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
MULTILOOP FEYNMAN DIAGRAMS AND DISTRIBUTION THEORY. PART 3: UV RENORMALIZATION IN MOMENTUM SPACE
A. N. Kuznetsov and F. V. Tkachov (Academy of Sciences, USSR, Moscow) Oct. 1990 42 p
(NIKHEF-H/90-17-Pt-3; ETN-91-99131) Avail: NTIS HC/MF A03

UV renormalization of multiloop diagrams is studied using the techniques of the As-operation developed in the precedent papers. A new representation of the Bogoliubov R-operation is obtained, which has the form of a substraction from the momentum space integrand of its asymptotic expansion at large integration momenta in the sense of the distribution theory. The substracted terms are obtained by applying to the integrand the As-operation with respect to all dimensional parameters (masses and external momenta) going at zero to an equal rate, and an additional renormalization (wherefrom the arbitrariness arises) of the logarithmically divergent term at the origin of the space of the integration momenta. It is shown that the class of substraction schemes thus defined contains the well known MS scheme of 't Hooft. ESA

N91-22856# Allied-Signal Aerospace Co., Kansas City, MO.
MULTIVARIATION CALIBRATION TECHNIQUES APPLIED TO NIRA (NEAR INFRARED REFLECTANCE ANALYSIS) AND FTIR (FOURIER TRANSFORM INFRARED) DATA
C. L. Long Feb. 1991 46 p
(Contract DE-AC04-76DP-00613)
(DE91-008159; KCP-613-4184) Avail: NTIS HC/MF A03

Multivariate calibration techniques can reduce the time required for routine testing and can provide new methods of analysis. Multivariate calibration is commonly used with near infrared reflectance analysis (NIRA) and Fourier transform infrared (FTIR) spectroscopy. Two feasibility studies were performed to determine the capability of NIRA, using multivariate calibration techniques, to perform analyses on the types of samples that are routinely analyzed at this laboratory. The first study performed included a variety of samples and indicated that NIRA would be well-suited to perform analyses on selected materials properties such as water content and hydroxyl number on polyol samples, epoxy content on epoxy resins, water content of desiccants, and the amine values of various amine cure agents. A second study was performed to assess the capability of NIRA to perform quantitative analysis of hydroxyl numbers and water contents of hydroxyl-containing materials. Hydroxyl number and water content were selected for determination because these tests are frequently run on polyol materials and the hydroxyl number determination is time consuming. This study pointed out the necessity of obtaining calibration standards identical to the samples being analyzed for each type of polyol or other material being analyzed. Multivariate calibration techniques are frequently used with FTIR data to determine the composition of a large variety of complex mixtures. A literature search indicated many applications of multivariate calibration to FTIR data. Areas identified where quantitation by FTIR would provide a new capability are quantitation of components in epoxy and silicone resins, polychlorinated biphenyls (PCBs) in oils, and additives to polymers. DOE

N91-22857# Sandia National Labs., Albuquerque, NM.
DIRECT OPTICAL PHASE SHIFTER FOR PHASED-ARRAY SYSTEMS
G. A. Vawter, V. M. Hietala, S. H. Kravitz, and W. J. Meyer 1991 5 p Presented at the SPIE International Symposium on Optical Engineering and Photonics in Aerospace Sensing, Orlando, 1-5 Apr. 1991
(Contract DE-AC04-76DP-00789)
(DE91-010480; SAND-91-0649C; CONF-910450-3) Avail: NTIS HC/MF A01

An all optical circuit in GaAs/AlGaAs for control of phased-array systems using a single photonic integrated circuit chip has the potential for high performance control of phased-array system from a small, lightweight, package. Such a circuit based exclusively on combinations of reverse-biased optical phase modulators, waveguide interconnects, corner reflectors, and power splitter combiners with optical-fiber output to the antenna elements has been designed at Sandia National Laboratories. This paper presents some basic features of optical phase modulators for photonic circuit applications and provide relevant performance data as achieved to date. Current structures have been shown to operate with a 76.5 degree/V-mm figure of merit at 1.06 micron and losses as low as 2/cm. A digital phase shifter to allow direct digital control of phased arrays is also proposed and demonstrated. DOE

N91-22858# California Univ., Berkeley. Lawrence Berkeley Lab.
COHERENCE, OPTICS AND APPLICATIONS OF X RAY WAVELENGTHS
D. Attwood Jul. 1990 9 p Presented at the 15th International Conference on X ray and Inner-shell Processes, Knoxville, TN, 9-13 Jul. 1990
(Contract DE-AC03-76SF-00098)
(DE91-009739; LBL-28729; CONF-900757-8) Avail: NTIS HC/MF A02

The extension of coherent optical techniques to the x-ray region of the electromagnetic spectrum opens many new opportunities

for science and technology based on very short wavelengths and on photon energies which span the primary atomic resonances of many elements. The topics covered include: synchrotron radiation facilities; x-ray optics; applications to the physical and life sciences; and the 'hand in hand' development of science and technology.
DOE

75 PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion.
For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

N91-22859# Institute of Plasma Physics, Prague (Czechoslovakia).
THE 15TH CZECHOSLOVAK SEMINAR ON PLASMA PHYSICS AND TECHNOLOGY, PART 1
May 1989 163 p In ENGLISH and CZECH Seminar presented 13-17 Mar. 1989
(IPPCZ-293/1-Pt-1) Avail: NTIS HC/MF A08
Papers presented at the 15th Czechoslovak Seminar on Plasma Physics and Technology are compiled. Part 1 contains papers related to the following subject areas: spectral characteristics of plasmas; spectroscopic diagnostics of plasmas; plasma temperature measurements; a study of plasma arcs; and plasma probes.
Author

N91-22860# Institute of Plasma Physics, Prague (Czechoslovakia).
THE 15TH CZECHOSLOVAK SEMINAR ON PLASMA PHYSICS AND TECHNOLOGY, PART 2
May 1989 212 p In ENGLISH and CZECH Seminar presented 13-17 Mar. 1989
(IPPCZ-293/2) Avail: NTIS HC/MF A10
Papers presented at the 15th Czechoslovak Seminar on Plasma Physics and Technology are compiled. Part 2 contains papers related to the following subject areas: plasma sprayed coatings; plasma jet spraying; plasmatrons; plasma diagnostics; plasma radiation measurements; CASTOR tokamak studies; and computerized simulation of plasma processes.
Author

N91-22861# Polytechnic Inst. of New York, Farmingdale.
MILLIMETER WAVE GENERATION BY RELATIVISTIC ELECTRON BEAMS AND MICROWAVE-PLASMA INTERACTION Final Report, 30 Sep. 1985 - 29 Sep. 1990
Spencer Kuo 4 Dec. 1990 68 p
(Grant AF-AFOSR-0316-85; AF Proj. 2301)
(AD-A231924; AFOSR-91-0037TR) Avail: NTIS HC/MF A04 CSCL 20/3
The design and operation of a compact, high power, millimeter wave source (cusptron) has been completed and proven successful. Extensive theoretical analysis of cusptron beam and rf dynamics has been carried out and published. Theory agrees beautifully with experiment. Microwave Bragg scattering due to been achieved by using expanding plasmas to upshift rf signal frequencies.
GRA

N91-22862# Technische Univ., Eindhoven (Netherlands). Atomic Collisions and Spectroscopy Group.
ETCHING STUDIES IN A MULTIPLE-BEAM SURFACE EXPERIMENT Ph.D. Thesis
Henricus Antonius Jo Senhorst 1990 215 p
(ETN-91-99168) Avail: NTIS HC/MF A10
The development of a multiple beam surface experiment for plasma etching related studies is reported. The experiment fully simulates the surface reactions in plasma etching: five beams of particles (ions, CFx radicals, reactive gas (e.g. XeF2), electrons and photons) can independently be admitted to a sample (Si, SiO2) in an ultrahigh vacuum arrangement. Relatively large beam fluxes on the sample are needed from the demand of reaction simulation. A quantitative calibration of the beam sources and the mass spectrometric detector is carried out on an absolute scale. A large effort was put into the development of the beam source of CFx radicals, which consists of an RF discharge in a 10 percent C2F6/90 percent He gas mixture followed by a mildly supersonic reaction. The spontaneous etching of Si by XeF2 is experimentally studied. The setup proved its capabilities and can now be used for a wide range of experiments.
ESA

N91-22863# Montana State Univ., Bozeman. Dept. of Mechanical Engineering.
CORROSION AND ARC EROSION IN MHD CHANNELS
R. J. Rosa and R. J. Pollina 30 Jul. 1990 12 p
(Contract DE-FG22-88PC-88928)
(DE91-008527; DOE/PC-88928/T2) Avail: NTIS HC/MF A03
The objective of this task is to study the corrosion and arc erosion of MHD materials in a cooperative effort with, and to support, the MHD topping cycle program. Materials tested in the Avco Research Laboratory/Textron facility, or materials which have significant MHD importance, will be analyzed to document their physical deterioration. Conclusions shall be drawn about their wear mechanisms and lifetime in the MHD environment with respect to the following issues; sulfur corrosion, electrochemical corrosion, and arc erosion. The impact of any materials or slag conditions on the level of power output and on the level of leakage current in the MHD channel will also be noted, where appropriate. The work performed to date in the analysis of channel gas side materials has served to identify and clarify the respective environments to which the various materials are subjected and identified a performance ranking of materials. For high voltage intercathode gaps, which show the most severe wear, the materials rank in the order from best to worst: W, Mo, 90WCu, 97W2Fe1Ni, 75WCu, and Cr. We have shown data which indicates that lifetime is sensitive to gap voltage. Therefore for conditions under which iron oxide addition maintains low voltage intercathode gaps 75WCu becomes an excellent cathode material.
DOE

N91-22864# Dartmouth Coll., Hanover, NH.
MAGNETOFLUID TRANSPORT
1991 5 p
(Contract DE-FG02-89ER-53298)
(DE91-010261; DOE/ER-53298/2) Avail: NTIS HC/MF A01
The goal of this activity is to understand the limiting factors in the containment and heating of a toroidally confined magnetofluid, seen as a model for a tokamak plasma, or to a lesser extent, for a toroidal pinch. Three main pieces of progress are: (1) detailed predictions for realistic plasma numbers of the helical, convective states to be expected in tokamaks driven at currents above the thresholds for the instability of the zero-flow axisymmetric profile with spatially uniform transport coefficients; (2) numerical study of tokamak equilibrium with Braginskii transport coefficients and an energy equation; and (3) determination of the characteristics of helically-deformed, convection-cell, plasma states by numerical methods. This is a one page presentation that is accompanied by an appendix of six selected abstracts dealing with plasma physics.
DOE

N91-22865# Yale Univ., New Haven, CT.
THEORY OF INCREMENTAL TURBULENT TRANSPORT IN TOKAMAKS
P. L. Similon 1991 8 p
(Contract DE-FG02-89ER-53300)
(DE91-010264; DOE/ER-53300/1) Avail: NTIS HC/MF A02
The goal of this research is to understand how the various aspect of turbulent transport operate in tokamaks in the presence of low frequency fluctuations such as drift waves or trapped electron modes.
DOE

N91-22866# Texas Univ., Austin. Fusion Research Center.
DISPERSION RELATIONS OF DENSITY FLUCTUATIONS OBSERVED BY HEAVY ION BEAM PROBE IN THE TEXT TOKAMAK
D. W. Ross, P. M. Schoch, J. W. Heard, T. P. Crowley, and R. L. Hickok Sep. 1990 36 p Prepared in cooperation with Rensselaer Polytechnic Inst., Troy, NY

(Contracts DE-FG05-88ER-53266; DE-FG05-88ER-53267)
(DE91-010422; DOE/ER-53266/31; FRCR-358) Avail: NTIS HC/MF A03

Wave numbers as functions of frequency for density fluctuations in the core of the TEXT tokamak are measured in Heavy Ion Beam Probe experiments by analyzing the relative phases of signals originating from nearby points in the plasma. The adjacent points are typically 2 cm apart, with their relative orientation (delta(r), delta(theta)) depending on position (r,theta). for angular frequencies omega is less than or equal to 10(exp 6)/s the signals are quite coherent, leading to reasonably well-defined 'dispersion relations.' These do not correspond to known modes of the drift wave type, i.e., ballooning or slab-like electron drift waves or ion temperature gradient modes. The effect of finite sample volume size does not significantly alter this conclusion. DOE

N91-22867# Wisconsin Univ., Madison. Dept. of Physics.
q-DEPENDENCE OF MAGNETIC TURBULENCE IN A TOKAMAK
S. C. Prager, R. N. Dexter, and D. E. Graessle Jan. 1991 53 p
(Contract DE-FG02-85ER-53198)
(DE91-009679; DOE/ER-53198/169) Avail: NTIS HC/MF A04

Low-frequency radial magnetic field turbulence has been measured over the full minor radius for discharges in the Tokapole 2 tokamak, and scaled over the range of edge safety factor 0.6 less than or equal to q(sub a) less than or equal to 5.0. It was found that q(sub a) served as a control parameter for both the magnetic fluctuation amplitude and the global confinement time. As q(sub a) is reduced from 5 to 0.6 the turbulence level increases by a factor of fifty while the confinement time decreases by more than a factor of ten. At q(sub a) less than or equal to 1, the full fluctuation amplitude is roughly large enough to account for the global confinement using simple estimates of collisionless stochastic magnetic transport. At high q(sub a), the turbulence is too small to account for transport using these estimates. Frequency spectra have been obtained from 10 to 400 kHz. For all q(sub a) most of the fluctuation power appears below 100 kHz. This low-frequency structure changes as the safety factor is varied. Although broadband in frequency, the long radial coherence lengths at these frequencies indicate global modes. For f greater than or equal to 100 kHz, the spectra become featureless, with a power-law frequency decay. Radial, poloidal, and parallel correlation analysis has been done as well. The parallel correlation length is estimated to be 150 +/- 10 cm. Radial and poloidal coherence lengths are of the order of the machine dimensions for frequencies below 100 kHz for all q(sub a). Poloidal mode number spectral information is obtained from two-point phase shift measurements, radial decay of fluctuations beyond the separatrix, and poloidal coherence measurements. The m-spectrum broadens as q(sub a) decreases. This might explain the increase in fluctuation amplitudes as q(sub a) decreases. It is suggested that the turbulence for all discharges is due to the same underlying cause or set of causes, and that the differences result from geometric effects associated with the variation in q(sub a). DOE

N91-22868# Massachusetts Inst. of Tech., Cambridge. Plasma Fusion Center.
AXISYMMETRIC CONTROL IN TOKAMAKS Ph.D. Thesis
D. A. Humphreys Feb. 1991 256 p
(Contract DE-AC02-78ET-51013)
(DE91-009794; DOE/ET-51013/291; PFC/RR-91-4) Avail: NTIS HC/MF A12

Vertically elongated tokamak plasmas are intrinsically susceptible to vertical axisymmetric instabilities as a result of the quadrupole field which must be applied to produce the elongation. The present work analyzes the axisymmetric control necessary to stabilize elongated equilibria, with special application to the Alcator C-MOD tokamak. A rigid current-conserving filamentary plasma model is applied to Alcator C-MOD stability analysis, and limitations of the model are addressed. A more physically accurate nonrigid plasma model is developed using a perturbed equilibrium approach to estimate linearized plasma response to conductor current variations. This model includes novel flux conservation and vacuum vessel stabilization effects. It is found that the nonrigid model predicts significantly higher growth rates than predicted by the rigid model applied to the same equilibria. The nonrigid model is then applied to active control system design. Multivariable pole placement techniques are used to determine performance optimized control laws. Formalisms are developed for implementing and improving nominal feedback laws using the C-MOD digital-analog hybrid control system architecture. A proportional-derivative output observer which does not require solution of the nonlinear Ricatti equation is developed to help accomplish this implementation. The nonrigid flux conserving perturbed equilibrium plasma model indicates that equilibria with separatrix elongation of at least kappa(sub sep) = 1.85 can be stabilized robustly with the present control architecture and conductor/sensor configuration. DOE

N91-22869# General Atomic Co., San Diego, CA.
AN EDGE DENSITY FLUCTUATION DIAGNOSTIC FOR DIII-D USING LITHIUM BEAMS
D. M. Thomas Oct. 1990 12 p
(Contract DE-FG03-90ER-54081)
(DE91-009814; GA-C-20285) Avail: NTIS HC/MF A03

This report covers the research conducted under US Department of Energy Grant No. DE-FG02-90ER54081 during the period 3/15/90 through 8/15/90. Highlights include the procurement of the highly stabilized beam energy power supply, and the acquisition of relevant high speed lithium fluorescence data from the edge region of both limiter (TEXT) and divertor (ASDEX) tokamak plasmas. We have also presented a paper at the Hyannis Plasma Diagnostics Conference (to be published in Review of Scientific Instruments) which covers the planned diagnostic system. The work on this project may be naturally organized according to the following six sub-areas: Ion source/beam system, neutralizer system, optical system, data acquisition, data analysis, and machine (DIII-D) interface. Progress in each of these areas will be discussed briefly. DOE

N91-22174*# North Dakota Univ., Grand Forks. Energy and Environment Research Center.
LOW-TEMPERATURE PLASMA TECHNOLOGY AS PART OF A CLOSED-LOOP RESOURCE MANAGEMENT SYSTEM
Melanie D. Hetland, John R. Rindt, Frank A. Jones, and Randal S. Sauer *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 444-459 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 20I

76 SOLID-STATE PHYSICS

Includes superconductivity.

For related information, see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

N91-22870# United Kingdom Atomic Energy Authority, Harwell (England).
A REVIEW OF THEORETICAL AND EXPERIMENTAL WORK ON THE STRUCTURE OF Ge(x)Si(1-x) STRAINED LAYERS AND SUPERLATTICES WITH EXTENSIVE BIBLIOGRAPHY
S. C. Jain, J. R. Willis (Bath Univ., England), and R. Bullough Sep. 1989 79 p
(AERE-R-13657) Avail: NTIS HC/MF A05

A review of theoretical and experimental work on the structure of Ge(x)Si(1-x) strained layers and superlattices is presented with extensive bibliography. The following subject areas are covered: (1) theory of strain energy, dislocation energy and critical layer thickness of lattice mismatched pseudomorphic Ge(x)Si(1-x) layers; (2) measurements of strain, critical layer thickness and temperature effects with comparison of experimental and theoretical results; (3) energies, stability and critical thickness of superlattices; and (4) summary of important results. Author

N91-22871# California Univ., Berkeley. Lawrence Berkeley Lab. Materials and Chemical Sciences Div.
EXPERIMENTAL AND THEORETICAL CHARACTERIZATION OF THE YBa2Cu3O7 / YBa2Cu4O8 PHASE TRANSFORMATION
M. Fendorf, C. P. Burmester, R. Gronsky, and L. T. Wille (Florida Atlantic Univ., Boca Raton.) Jul. 1990 8 p Presented at the Symposium on Surface Processing and Laser Assisted Chemistry in Conjunction With the Spring Meeting of the European Materials Research Society, Strasbourg, France, 29 May - 1 Jun. 1990
(Contracts DE-AC03-76SF-00098; MDA972-88-J-1002)
(DE90-015309; LBL-28669; CONF-900577-1) Avail: NTIS HC/MF A02

The YBa2Cu4O8 to YBa2Cu3O7 transformation in mixed phase, superconducting YBaCuO is investigated by high resolution transmission electron microscopy and static lattice, three dimensional, Monte Carlo computer simulations. Micrographs reveal dislocations and stacking faults associated with the transformation that are accurately predicted by the calculations and seen in 'snapshots' of the simulated structures. An atomic mechanism involving the intercalation of extra CuO planes by partial dislocation climb is proposed for the YBa2Cu4O8 / YBa2Cu3O7 phase change. DOE

N91-22872# National Inst. of Standards and Technology, Gaithersburg, MD. Semiconductor Electronics Div.
SEMICONDUCTOR MEASUREMENT TECHNOLOGY: A PROGRAMMABLE REVERSE-BIAS SAFE OPERATING AREA TRANSISTOR TESTER Final Report
D. W. Berning Aug. 1990 62 p
(PB91-112821; NIST/SP-400/87) Avail: NTIS HC/MF A04
CSCL 20L

The circuits and construction of a transistor turn-off breakdown tester are described. Principles of operation for various circuits in the tester are discussed, as well as those for the complete system. Construction notes are given with layout guidelines. Included are complete circuit schematics and details of construction of special parts used in the tester. Specifications and performance data are also given. GRA

N91-22873 Minnesota Univ., Minneapolis.
METAL-SEMICONDUCTOR AND CONDENSED GAS-SEMICONDUCTOR INTERFACE FORMATION Ph.D. Thesis
Steven Gene Anderson 1990 104 p
Avail: Univ. Microfilms Order No. DA9100918

Two adatom/III-V semiconductor interfaces were examined with high resolution synchrotron radiation photoemission spectroscopy. An investigation of a metal-semiconductor interface, Al/GaAs(110), was performed as a function of substrate temperature to correlate the evolving interfacial chemistry and morphology with band bending. Detailed examination shows a separation in energy of approximately 1.0 eV for the Al 2p binding energy for n- and p-type GaAs at submonolayer coverages. This equals the difference in band bending for the two substrates, demonstrating that the adatom energy reference is an intrinsic level of the semiconductor, not the Fermi level. Substrate band bending approaches its final value when E(sub f) becomes the energy reference for the overlayer, and this occurs at the onset of metallic overlayer behavior. The overlayer morphology, disrupted atom distribution, and band bending depends on the substrate temperature, while the amount of substrate disruption and the final value of E(sub f) in the gap at high coverage does not. Temperature-dependent band bending observed below a monolayer can be understood by considering the importance of a surface photovoltage. Studies of a condensed gas-semiconductor interface, O2/GaAs(110), were conducted at 20 K to examine the dynamics of photo-induced oxidation. Detailed core level analysis of photon exposure-dependent data demonstrate that As(+1)- and As(+3)-like bonding configurations form in a step-wise fashion with approximately equal reaction probabilities for the two steps. The high sticking coefficient for O2 at 20 K makes it possible to locally oxide the surface ten orders of magnitude more efficiently than in equivalent experiments at 300 K. Reaction cross sections determined from modeling the dynamics of the reaction processes indicate that an oxidation mechanism involving secondary electrons is operative. Results are also presented for the competition between continued reaction and photon-induced oxygen desorption, where desorption occurres via a first order process. Dissert. Abstr.

N91-22874 Oxford Univ. (England).
THEORY OF DEFECT INTERACTIONS IN METALS Ph.D. Thesis
Roger Thetford 1989 130 p
Avail: Univ. Microfilms Order No. BRD-90998

The static relaxation program, DEVIL, was updated to use N-body Finnis-Sinclair potentials. Initial calculations of self-interstitial and monovacancy formation energies confirm that the modified program is working correctly. An extra repulsive pair potential overcomes some deficiencies in the published Finnis-Sinclair potentials. The modified potentials are used to calculate interstitial energies and relaxations in the body centered cubic (b.c.c.) transition metals: vanadium, niobium, tantalum, molybdenum, and tungsten. Further adaptation enables DEVIL to model dislocations running parallel to any lattice vector. Periodic boundary conditions are applied in the direction of the dislocation line, giving an infinite straight dislocation. The energies per unit length of two different dislocation are compared with experiment. A study of migration of point defects in the perfect lattice provides information on the mobility of interstitials and vacancies in a migration step comes under scrutiny. The total energy needed to form and migrate an interstitial is compared with that required for a vacancy. The interaction between point defects and dislocations is studied in detail. Binding energies for both self-interstitials and monovacancies at edge dislocations are calculated for the five metals mentioned above. Formation energies of the point defects in the neighborhood of the edge dislocation are calculated for niobium, and the extent of regions from which the defects are spontaneously absorbed are found. For split dumbbell interstitials, the size, and shape of the absorption region depends on the orientation of the dumbbell. Migration of both interstitials and vacancies into the absorption zone is studied; the presence of the dislocation has a particularly dramatic effect on vacancy migration. The results on absorption zones are related to the dislocation sink strengths vital in radiation damage theory.
Dissert. Abstr.

N91-22875 State Univ. of New York, Stony Brook.
A STUDY OF GRAIN BOUNDARY STRUCTURE IN YBa2Cu3O(7-DELTA) Ph.D. Thesis
Natarajan Chandrasekhar 1990 206 p
Avail: Univ. Microfilms Order No. DA9101585

Transmission electron microscope observations of the microstructure of large-angle grain boundaries in bulk sintered specimens of YBa2Cu3O(7-delta) were made. The boundaries were found to possess ordered structure. Most boundaries exhibit a regular network of grain boundary dislocations. A 'Coincidence Site Lattice' model was developed and the observed structures were found to be explicable in terms of this model. Certain amorphous boundaries indicating the presence of an intergranular wetting phase were also observed. These amorphous boundaries could not be related to CSL orientations of two neighboring grains. Grain boundaries also exhibit oxygen depletion, which was found to vary with the misorientation angle. Grain boundary structure was found to be quite sensitive to the extent of oxygen depletion.
Dissert. Abstr.

N91-22876# Aerospace Corp., El Segundo, CA. Lab. Operations.
NEUTRON DEGRADATION OF THE I-V CHARACTERISTICS OF AlGaAs/GaAs MODULATION-DOPED FIELD EFFECT TRANSISTORS
Richard J. Krantz, Walter L. Bloss, and Michael J. OLoughlin 4 Jan. 1991 12 p
(Contract F04701-88-C-0089)

(AD-A231696; TR-0090(5925-07)-2; SSD-TR-90-55) Avail: NTIS HC/MF A03 CSCL 09/1

A triangular-well, one-subband depletion layer model has been developed which applies over the range of I-V characteristics from subthreshold to saturation, some nine orders of magnitude in source-drain current. The model has been extended to describe neutron degradation of source-drain current and transconductance. GRA

N91-22877# Army Lab. Command, Fort Monmouth, NJ. Electronics Technology and Devices Lab.

FABRICATION AND CHARACTERIZATION OF YTTRIUM BARIUM COPPER OXIDE SUPERCONDUCTORS FOR MICROWAVE APPLICATIONS Technical Report, 1987 - 1989

Douglas J. Basarab, Michelle A. Dornath-Mohr, Donald W. Eckart, Robert D. Finnegan, and Joseph P. Klimek Jan. 1991 30 p

(AD-A231713; SLCET-TR-90-16) Avail: NTIS HC/MF A03 CSCL 09/1

High temperature superconductors offer several advantages over normal conductors for low power device applications. Bulk ceramic processing parameters are investigated to define optimum conditions for materials useful in microwave applications. Calcining, sintering, and reaction atmosphere were systematically varied in bulk samples. The density, microstructure and composition, dc resistivity, microwave Q, and surface resistivity were followed as a function of sintering temperature. An optimum sintering temperature is defined. GRA

N91-22878# SRI International Corp., Menlo Park, CA.

MECHANICAL PROPERTIES OF SEMICONDUCTORS AND THEIR ALLOYS Annual Report, Mar. - Oct. 1990

A. Sher, M. A. Berding, M. VanSchilfgaarde, S. Krishnamurthy, and A. T. Paxton Nov. 1990 26 p

(Contract F49620-88-K-0009)

(AD-A231820; AFOSR-91-0006TR) Avail: NTIS HC/MF A03 CSCL 09/1

This annual report of AFOSR contract F49620-88-K-0009 summarizes the work accomplished on studies of mechanical properties of semiconductors and their alloys, and plastic flow and intermetallic compounds. (1) A simple relationship between the elastic constants of semiconductor is found. (2) A systematic study of tight-binding parameters to fit cohesive energy, bulk modulus, and shear coefficients of all diamond and zinc-blende semiconductors has been carried out. (3) An additional, nonequilibrium mechanism is suggested as a possible explanation of ordering in lattice-matched alloys. (4) A KKR-CPA theory is being generalized to study semiconductors. (5) Based on our calculation of surface sublimation energies, a charge transfer mechanism is proposed that affect ordering on semiconductor surfaces. The surfaces of wide gap, ionic compounds are expected to exhibit superlattice arrangements of atoms and vacancies. Consequent effect on epitaxial growth is discussed. (6) Static structural and deformation properties, such as ideal twin-strength and ideal twin-stresses, of metals are studied in a non-self-consistent total energy calculations using the Harris-Foulkes approximation. GRA

N91-22879# Stanford Univ., CA. Electronics Lab.

INVESTIGATION OF SCHOTTKY BARRIER ON GaAs AND InP USING A MULTI-DISCIPLINED APPROACH Final Report, 15 Jul. 1986 - 14 Jan. 1990

William E. Spicer 29 Oct. 1990 76 p

(Grant AF-AFOSR-0223-86; AF Proj. 2306)

(AD-A231822; AFOSR-91-0024TR) Avail: NTIS HC/MF A05 CSCL 09/1

Major progress is reported in understanding and bringing under control metal/GaAs contacts. The key to this realization that defects at the interface can control the electrical properties of such contacts. By properly controlling these defects it appears that the Schottky barrier height may be varied strongly to obtain the desired values for specific applications, i.e. large barriers for Schottky gates and small values for ohmic contacts. Evidence is presented that the key defects are As and Ga antisites. The Fermi level position at the interface, E(sub f), is the most important parameter in determining the electrical properties of the contract. Under normal conditions the As antisite levels dominate and the Fermi level is pinned near mid-gap. Producing excess As moves E(sub f) toward the CBM whereas, excess Ga moves it toward the VBM. GRA

N91-22880# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.

FOCUSED ION BEAM FABRICATION OF MICROELECTRONIC STRUCTURES Final Report, 8 Sep. 1987 - 30 Sep. 1990

John Melngailis Dec. 1990 109 p

(Contract DAAL03-87-K-0126)

(AD-A231848; ARO-24871.7-EL) Avail: NTIS HC/MF A06 CSCL 20/12

The development of the capability focusing many species of ions to beam diameters well below 0.1 micron has led to many applications, from many applications, from the repair of photomasks and integrated circuits to the fabrication of quantum effect devices. The work reported here has concentrated on ion induced deposition. This novel method of film growth combines patterning and deposition in a single step. It is used in repair processes to locally add material, and it may also be useful in making conductors and contact in situ, for example, on III-V compounds which cannot be exposed to the ambient between MBE growth steps. In ion induced deposition a local gas ambient of, for example, an organometallic, is created where the ion beam is incident. A film grows where the beam is scanned. Focused ion beam induced deposition of gold and platinum was demonstrated, characterized, and developed. Features down to 0.1 micron line width have been written as well as, thick (approx. 1 micron) features with steep sidewalls. The microstructure of the gold and platinum deposits has been studied by transmission electron microscopy (TEM). The Pt deposits were found to be amorphous while the gold growth begins as islands an becomes columnar. Measurements were made of the dependence of growth rate on average ion current, ion energy, ion species, and precursor gas pressure and a macroscopic and microscopic model of the process developed. GRA

N91-22881# Hughes Research Labs., Malibu, CA.

NONLINEAR PROPERTIES OF NOVEL MATERIALS Final Report, 1 Mar. 1987 - 28 Oct. 1990

Juan F. Lam Jan. 1991 186 p

(Contract DAAL03-87-C-0001)

(AD-A231957; HAC-REF-G0657; ARO-23969.6-PH) Avail: NTIS HC/MF A09 CSCL 20/3

Millimeter wave nonlinearities in semiconductor superlattices are analyzed. Self-induced transparency, giant third order susceptibilities and third harmonic generation are predicted at 250 GHz. Enhanced nonlinear optical properties of quantum dots are quantified, in agreement with experiments. Application to lasers indicates threshold current density of the order of amperes per centimeter squared, temperature independent threshold condition, and visible light emission for 50 A dots. The origin of sublinear intensity dependence of the erasure rate in barium titanate is attributed to the presence of shallow impurities. The exponent has resonances as a function of the grating wave vector, and is linear function of temperature. Self-oscillatory behavior of phase conjugate wave in self-pumped photorefractive is shown to arise from the photovoltaic effect. The first resonantly enhanced self-pumped phase conjugate mirror is demonstrated at 0.852 nm. Self-starting temporal oscillation in resonant two-wave mixing is attributed to the phenomenon of light induced drift. Third order optical susceptibilities at 10.6 micro m in semiconductor superlattices are calculated to be of the order of 10.0001 esu. Application to laser hardening of FLIR systems, using the techniques of light induced prism, shows dynamic range 10,000, subnanosecond response time, and tens of milliwatts per centimeter squared differential intensity threshold at the aperture plane. GRA

N91-22882# Aerospace Corp., El Segundo, CA. Materials Sciences Lab.
DOUBLE-CRYSTAL X RAY DIFFRACTION STUDIES OF Si ION-IMPLANTED LASER-ANNEALED GaAs
Paul M. Adams 8 Jan. 1991 47 p
(Contract F04701-88-C-0089)
(AD-A232006; TR-0090(5945-07)-2) Avail: NTIS HC/MF A03 CSCL 20/2

Double-crystal x ray rocking curves and topographs have been used to study the relief of strain produced by pulsed laser annealing in 28Si+ ion-implanted GaAs. X ray rocking curves of 140 keV 2 x 10(exp 14)/sq cm as-implanted GaAs indicated that the upper 2500 angstroms of the sample had been strained to a maximum of 0.38. Rocking curves from two of a single-shot laser anneal sites with the highest energy densities (and largest areas of annealing) indicated that the ion-implantation strain had been almost completely relieved. X ray rocking curves of the 180 keV 5 x 10(exp 15)/sq cm as-implanted GaAs revealed that the surface of the sample has been strained to a depth of 6000 angstroms with a maximum strain of 0.50 percent. Rocking curves from rastered laser anneal sites indicated that considerable strain remained in the sample. GRA

N91-22883# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Inst. fuer Raumsimulation.
FOURTH SUMMER SCHOOL ON MICROGRAVITY: CONFERENCE SUMMARIES AND FORUM LECTURES [VORTRAGSKURZFASSUNGEN UND TEILNEHMERFORUM DER 4. SOMMERSCHULE MIKROGRAVITATION]
G. Otto, ed. Aug. 1990 204 p In ENGLISH and GERMAN Conference held in Cologne, Fed. Republic of Germany, 5-8 Jun. 1990
(IB-333-90/10; ETN-91-99077) Avail: NTIS HC/MF A10

The fundamentals of crystal growth are presented. Phase diagram, crystal structure, growth kinetics and characterization methods are outlined. The different growth processes in a microgravity environment and the results of space conducted experiments are discussed. Particular attention is given to flows in melts and Marangoni convections which work on growth under the form of striations. An overview of crystalline high temperature superconductors, and of the preparation of organic monocrystals in space experiments is given. The German microgravity program and astronaut training are presented. The Microgravity User Support Center (MUSC) is described. For individual titles, see N91-22884 through N91-22913.

N91-22884# Deutsche Agentur fuer Raumfahrtangelegenheiten G.m.b.H., Bonn (Germany, F.R.). Hauptabt. Forschung unter Schwerelosigkeit.
THE GERMAN MICROGRAVITY PROGRAM AND FLIGHT OCCURRENCES [DEUTSCHES MIKROGRAVITATIONSPROGRAMM UND FLUGGELEGENHEITEN] **c29**
H. Binnenbruck *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 1-12 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

Various microgravity research programs organized by the German agency for space affairs are reviewed. Research fields and microgravity duration tests are mentioned. The organizations and countries which take part in international research are quoted. Details are given on the main working scope of the various German research centers. ESA

N91-22885# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.).
ASTRONAUT TRAINING [ASTRONAUTENTRAINING] **c53**
Renate Bruemmer *In its* Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 13-20 In ENGLISH and GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The training concept is defined. The astronauts should perfectly understand the experiments performed during spaceflight and they should be familiar with the payload onboard the Spacelab. The aim of the training is to give the required knowledge to astronauts and to foster the formation of a team. As a D2 mission is being prepared and further Spacelab flights are envisaged, training phases, basic training, lectures, operational training, simulation, and orbiter crew training are described. ESA

N91-22886# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Inst. fuer Werkstoff-Forschung.
PRINCIPLES OF CRYSTAL GROWTH, PART 1 [GRUNDLAGEN DES KRISTALLWACHSTUMS, 1]
Bernd O. Hildmann *In its* Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 21-33 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

A definition is given for crystals, monocrystals, ideal crystals, and real crystals. Symmetries are shown from patterns. The link between crystal growth science and other disciplines, such as flow mechanics is outlined. The principles of crystal descriptions are shown from pattern models. Phase diagrams are described as the most important tool for crystal growth. Various types of phase diagrams are presented. The diffusion boundary layer is focused. ESA

N91-22887# Freiburg Univ. (Germany, F.R.). Inst. fuer Kristallographie.
PRINCIPLES OF CRYSTAL GROWTH, PART 2 [GRUNDLAGEN DES KRISTALLWACHSTUMS, 2]
K. W. Benz *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 35-37 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

Subjects covered are: directional solification, growing kinetics, zone melts, distribution coefficient, constitutional undercooling and doping agent striations. A tellurium segregation curve and a comparison between simple solidification and zone solidification are given. ESA

N91-22888# Freiburg Univ. (Germany, F.R.). Inst. fuer Kristallographie.
THE GROWING PROCESS [ZUECHTUNGSVERFAHREN]
K. W. Benz *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 39-44 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The monocrystal growing process is outlined. Growing from melts and Bridgeman growing are described. Liquid phase epitaxy and solution zone extraction for III to V semiconductors are determined. Results are given for the growing of III-V semiconductors. A television program on gallium arsenide is presented. ESA

N91-22889# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Inst. fuer Werkstoff-Forschung.
PHYSICAL PROPERTIES AND REAL STRUCTURES [PHYSIKALISCHE EIGENSCHAFTEN UND REALSTRUKTUREN]
Bernd O. Hildmann *In its* Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 45-54 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The geometry of crystal defects is considered. The chemical imperfections correspond to point defects. In the framework of the experiments conducted on crystal growth of semiconductor crystals in space, doping and structural homogeneity for mixed crystallization and minimum structural defects is discussed. Physical properties in anisotropic media are described. ESA

N91-22890# Giessen Univ. (Germany, F.R.). Inst. fuer Physik.
FLOWS IN MELTS AND MARANGONI CONVECTION [STROEMUNGEN IN SCHMELZEN UND MARANGONI-KONVEKTION]
D. Schwabe *In* DLR, Fourth Summer School on Microgravity: Conference Summaries And Forum Lectures Aug. 1990 p 55-72 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The transport processes in the main phase, in particular the melts and the gravity in the convective transport process are considered. The fundamental meaning of convection in the technique of crystal growth is explained in general. The meaning of special convection phenomena is discussed in detail. Particular attention is given to Marangoni convection under microgravitation. ESA

N91-22891# Freiburg Univ. (Germany, F.R.). Inst. fuer Kristallographie.
RESULTS OF CRYSTAL GROWTH EXPERIMENTS IN SPACE [ERGEBNISSE VON KRISTALLZUECHTUNGSEXPERIMENTEN IM WELTRAUM]
A. Croell *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 73-84 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The results described concern experiments on the influence of convection flows on the doping agent distribution in silicon and germanium as technically important semiconductor elements. The process for melting growth of semiconductor crystals is described. Doping agent inhomogeneities in silicon and germanium are given. Growth experiments for silicon and germanium under microgravity are described. ESA

N91-22892# Johann-Wolfgang-Goethe-Univ., Frankfurt am Main (Germany, F.R.). Inst. fuer Physik.
MONOCRYSTALLINE HIGH TEMPERATURE SUPERCONDUCTOR [EINKRISTALLINE HOCHTEMPERATUR-SUPRALEITER]
W. Assmus *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 85-98 In ENGLISH and GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

Crystal growth of YBa2Cu3O7 high temperature superconductors is discussed. The lack of a proper crucible material, the tetragonal/orthotrombic phase transformation twinning, and the necessity of oxygen loading make it difficult to grow a perfect monocrystal. The present most favorable growing process is a quasi crucible free method. Working under microgravity is shown to be of interest when growing high temperature superconductor crystals. In such conditions greater melts can be floated without crucible material through an ultrasonic field. Perfect monocrystals can be obtained by a slow cooling. ESA

N91-22893# Freie Univ., Berlin (Germany, F.R.). Inst. fuer Biochemie.
CRYSTALIZATION OF RIBONUCLEIC ACID AND PROTEIN IN MICROGRAVITY CONDITIONS [KRISTALLISATION VON RNA UND PROTEINEN UNTER MIKROGRAVITATIONSBEDINGUNGEN]
V. A. Erdmann *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 99-111 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

Protein biosynthesis is illustrated, and the parameters influencing crystallization are given. The crystallization principles of the Cosima Mission, the crystallization chamber of the Photon Mission, and the cryostat experiments of the D2 mission are illustrated. The ribosome's structure and function within the living cell are discussed. ESA

N91-22894# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.).
THERMAL ANALYSES FOR EXPERIMENT PREPARATION WITH THE EXAMPLE OF A MIRROR FURNACE [THERMISCHE ANALYSEN ZUR EXPERIMENTVORBEREITUNG AM BEISPIEL EINES SPIEGELOFENS]
H. P. Schmidt *In its* Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 113-121 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The thermal model of the mirror furnace allows the prediction of the temperature profile on a reference specimen. The influence of gaseous atmosphere is examined. The measuring technique is improved by radiometry and a reference specimen with a movable temperature sensor. The models are used on 'genuine' crystal specimens. The temperature depends on surface properties, thermal conductivity, and specific heat. The problem of latent heat in the melting zone is examined. The thermal analyses are to be used in the experiments for the first European Retrieval Carrier (EURECA) Mission. ESA

N91-22895# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.).
USER SUPPORT AND GROUND SUPPORT PROGRAM, WITH THE EXAMPLE OF EURECA [NUTZERUNTERSTUETZUNG UND BODENBEGLEITPROGRAMM AM BEISPIEL VON EURECA] **c29**
B. Paetz and G. Otto *In its* Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 123-132 In ENGLISH and GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The tasks of the Microgravity User Support Center (MUSC) are defined. MUSC offers the function of a User Support and Operation Center (USOC). The concept of a ground support program is given, and the mission support program tasks are detailed. Preparation work is currently being done for the second German Spacelab Mission, the European Retrieval Carrier (EURECA), and the ESA unmanned experimentation platform. ESA

N91-22896# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Inst. fuer Werkstoff-Forschung.
INVESTIGATION OF THE SHAPE OF THE SOLID-LIQUID PHASE FRONT IN THE BRIDGMAN-STOCKBARGER PROCESS [UNTERSUCHUNGEN ZUR FORM DER FEST-FLUESSIG PHASENFRONT BEIM BRIDGMAN-STOCKBARGER VERFAHREN] **c29**
U. Moeller *In its* Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 133-134 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The shape (for example the curvature) of the solid-liquid phase front is an important parameter which influences crystal quality in the crystal growth of semiconductor materials with the Bridgeman-Stockbarger process. The dependency of the phase front shape on its positions in the baffle was calculated by several working groups. The differences between calculation and experimentation result from the different boundary conditions. The gradient region in the experiment is three times as big as in the calculations. ESA

N91-22897# Erlangen-Nuremberg Univ. (Germany, F.R.). Lehrstuhl fuer Werkstoffe der Elektrotechnik.
GROWING OF GaAs MONOCRYSTALS AFTER THE FLOATING ZONE PROCESS UNDER MICROGRAVITY [ZUECHTUNG VON GAAS-EINKRISTALLEN NACH DEM FLOATING-ZONE-VERFAHREN UNTER MICROGRAVITY] **c29**
F. M. Herrmann *In* DLR, Fourth Summer School in Microgravity: Conference Summaries and Forum Lectures Aug. 1990

p 135-138 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

GaAs as a semiconductor material, is gaining importance in the field of opto-electronics and very rapid microelectronic circuits. Therefore, requirements for purity and homogeneity are higher, and crystal growth processes must to be improved. The advantages of the Floating Zone (FZ) process under microgravity are given. Microgravity experiments are described. ESA

N91-22898# Freiburg Univ. (Germany, F.R.). Inst. fuer Kristallographie.
CuInSe2 MONOCRYSTAL GROWTH [EINKRISTALLZUECHTUNG VON CUINSE2]
A. Baldus *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 139-140 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

Synthesis manufacture of CuInSe2 is described. The advantage of the process is that the mixing proportions of the binary compounds Cu2Se and In2Se3 can be variegated. The crystal growth process using the Bridgman Method and the Traveling Heater Method (THM) are carried out in a mirror furnace. ESA

N91-22899# Martin Luther-Univ., Halle-Wittenberg (German D.R.). Sektion Physik.
EXAMINATION OF THE SEGREGATION OF TELLURIUM IN BiSbTe3 [UNTERSUCHUNBGEN ZUR SEGREGATION VON TELLUR IN BISBTE3]
P. Reinshaus and H. Suessmann *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 141-144 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The segregation profiles of tellurium are obtainable by measurement of the local Seebeck coefficient. The Favier model describes the segregation and allows the determination of the model parameter. The distribution coefficient is situated over the thermodynamical equilibrium value. The concentration compensation in the melt is convective and diffusive, so that a thorough convective mixing of the melt can be closed. ESA

N91-22900# Freiburg Univ. (Germany, F.R.). Inst. fuer Kristallographie.
THERMOANALYTIC AND ELECTRIC ANALYSES OF THE TlSbSe2 SEMICONDUCTOR [THERMOANALYTISCHE UND ELEKTRISCHE UNTERSUCHUNGEN AN DEM HALBELITER TLSBSE2]
M. Salk, K. Wacker, J. Fischer, and V. Kraemer *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 145-148 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The phase transformations were examined using Difference Thermal Analysis (DTA), dilatometry and powder diffractometry. The existence of a Room Temperature (RT) phase, High Temperature (HT) phase and dual metastable phase was detected. During heating the RT phase is submitted to phase transformation. During cooling the HT phase results from a phase transition. The electrical properties depend strongly on the doping. Crystals are grown according to the horizontal Bridgman process, under defined selenium vapor pressure. The layer arrangement of the RT phase for TlSbSe2 is represented. ESA

N91-22901# Bonn Univ. (Germany, F.R.). Mineralogisch-Petrologisches Inst.
DIRECTIONAL SOLIDIFICATION OF THE LiF-LiBaF3 EUTECTIC SYSTEM [GERICHTETE ERSTARRUNG DES EUTEKTISCHEN SYSTEMS LIF-LIBAF3]
K. Dupre and M. Neuroth *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 149-152 In GERMAN (For primary document see N91-22883 14-76)
(Contract BMFT-01-QV-89873)
Avail: NTIS HC/MF A10

Chemical and physical properties of the system and its components are tabulated. A review of the various experiment parameters obtained in the various tests is given. The growth is carried out according to the Bridgman-Stockbarger process. A process is developed for the measurement of eutectic structure, using a semi automatic image analysis. ESA

N91-22902# Max-Planck-Inst. fuer Metallforschung, Stuttgart (Germany, F.R.).
MONOCRYSTAL GROWTH FROM HIGH LIQUESCENT METALS UNDER ULTRAHIGH VACUUM [EINKRISTALLZUECHTUNG VON HOCHSCHMELZENDEN METALLEN IM ULTRAHOCHVAKUUM]
Peter Keppler *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 153-154 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The electron beam zone melting has proved to be the most proper method for the growth of pure monocrystals from high liquescent metals. High melting point crystals, such as niobium, tungsten, molybdenum are preferably grown. Cleaning is produced through vaporizing metallic impurities with high pressure steam on the one hand, and through zone cleaning action on the other hand. The main applications for such crystals are: radiation damages, hydrogen behavior in metals, measurement of mechanical properties. For purity control, electrical residual resistance measurement gave good results. X-ray methods are used for the detection of crystal defects. Gamma diffractometry is used for a precise orientation of monocrystals. ESA

N91-22903# Technische Hochschule, Aachen (Germany, F.R.). Helmholtz-Inst. fuer Biomedizinische Technik.
DIRECTIONAL SOLIDIFICATION OF AQUEOUS SOLUTIONS [GERICHTETE ERSTARRUNG VON WAESSRIGEN LOESUNGEN]
Bernhard Nunner *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 155-158 In GERMAN (For primary document see N91-22883 14-76)
(Contract DFG-Ra-335/5-1)
Avail: NTIS HC/MF A10

Different types of freeze beds were designed in connection with a microscope, in order to develop a cryomicroscope. A new concept for such a freeze bed developed for the directional solidification of specimens is described. It is a direct realization of the crystal growing Bridgman process. As the ice front is stationary in laboratory coordinate systems, on account of the stationary temperature profile, the dynamic development of the ice front can be directly examined, using a microscope or a video system. A model based on an NaCl H2O system was built, in good agreement with measurements. ESA

N91-22904# Max-Planck-Inst. fuer Festkoerperforschung, Stuttgart (Germany, F.R.).
KINETIC STRIATIONS IN EARTH- AND SPACE-GROWN SEMICONDUCTOR CRYSTALS
E. Bauser and Y. C. Lu (Institute of Semiconductor Devices, Beijing, China) *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 159-160 (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

It is shown that the genesis of the kinetic striations is closely related to particular morphologic features of the growth interface, such as shallow terraces and valleys. Methods to identify kinetic striations in Earth grown crystals are described. Since microsegregation effects are not alleviated in a gravitationless environment, kinetic striations are expected to be residual striations in space grown crystals. An adequate control of the kinetics of

growth steps is necessary to obtain striation free crystals on Earth and in space, and all kinds of convection are to be respectively reduced and eliminated. ESA

N91-22905# Academy of Sciences, Berlin (German D.R.). Inst. fuer Kosmosforschung.
RESULTS OF EXAMINATION OF UNSTEADY CONVECTION OF VERTICAL THERMALLY UNSTABLE Bi-Sb-Te MELTS [UNTERSUCHUNGSERGEBNISSE ZUR INSTATIONAEREN KONVEKTION VON VERTIKAL, THERMISCH INSTABIL ANGEORDNETEN BI-SB-TE-SCHMELZEN]
R. Kuhl, F. Koenig, and R. Roestel *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 161-164 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

Using a vertical destabilizing crystal growth arrangement, the characterization of the hydrodynamic behavior of Bi-Sb-Te alloys is obtained under the form of a dependency of the critical Rayleigh number on the melt geometry ratio. Low temperature gradients and greater geometry ratios direct to a greater hydrodynamic stability and allow microinhomogeneities to be avoided under the form of growth striations. ESA

N91-22906# Giessen Univ. (Germany, F.R.). Inst. fuer Physik.
MEASUREMENT OF THE CRITICAL Ma NUMBER VERSUS Pr NUMBER IN FLOATING ZONE
D. Shwabe, Xiaodong Da (Lanzhou Univ., China), and A. Scharmann *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 165-169 (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

A tendency of Prandtl (Pr) number variation with Marangoni (Ma) number was shown. An experiment was designed to confirm this theory. Paraffins were chosen as the working liquids. The change of temperature near the zone surface was measured in order to detect the transition point of convection developing from stable state to oscillating flow. Final results showed the critical Ma number depending on the Pr number. The theoretical model is based on an infinite zone length, but only a 3 mm zone was used in the experiment. For further proof of this model, the experiment should be extended to floating zones of alloys. ESA

N91-22907# Erlangen-Nuremberg Univ. (Germany, F.R.). Lehrstuhl fuer Werkstoffe der Elektrotechnik.
TWO-DIMENSIONAL NUMERICAL SIMULATION OF CONVECTION PROCESSES FOR MELTS IN A LIQUID ENCAPSULATED CZOCHRALSKI (LEC) ARRANGEMENT WITH MAGNETIC FIELD [ZWEIDIMENSIONALE NUMERISCHE SIMULATION VON KONVEKTIONSVORGAENGEN IN DER SCHMELZE BEIM CZOCHRALSKI-KRISTALLZIEHVERFAHREN (LEC) MIT MAGNETFELD]
M. Hannweber *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 171-176 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The action of the magnetic field resulted in a transfer from unsteady to steady flow. For crystal rotation an additional unsteadiness occurred only at very high rotation rates. The consideration of the melt meniscus influenced the flow profile. The crucible rotation caused no change in the stationary character of the solution. A good agreement was found between the mathematical model, numerical results and practical tests. The magnetic field induced a Lorentz force which is used as an additional term in the pulse equation. The program used allows the melt geometry to be known exactly. ESA

N91-22908# Freiburg Univ. (Germany, F.R.). Inst. fuer Kristallographie.
APPLICATION OF THE FINITE DIFFERENCE METHOD TO THE CALCULATION OF TEMPERATURE DISTRIBUTIONS IN GROWTH AMPOULES FOR MIRROR FURNACES [ANWENDUNG DER FINITE-DIFFERENZEN-METHODE AUF DIE BERECHNUNG VON TEMPERATURVERTEILUNGEN IN ZUECHTUNGSAMPULLEN FUER SPIEGELOEFEN]
Bernd Lexow *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 177-178 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The mathematical model requirements are defined for growth ampoules. The boundary conditions deal with the mirror reflexion degree, the specimen, the lamp and ampoule alignment, the quartz glass, the light source, and the calculation of the heat transfer in the solution zone. Calculation results are compared to growth results. ESA

N91-22909# Hamburg Univ. (Germany, F.R.).
THE SEGREGATION BEHAVIOR OF AlBi, AlPb AND AbIn MONOTECTIC ALLOYS FOR DIFFERENT CODING UNDER GRAVITY [DAS ENTMISCUNGSVERHALTEN DER MONOTEKTISCHEN LEGIERUNGEN AL-BI, AL-PB UND AB-IN BEI UNTERSCHIEDLICHER ABKUEHLUNG UNTER SCHWERKRAFT] **c26**
Xueli Wei (Academia Sinica, Shenyang, China) *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 179-181 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The test results show that the structures of the specimens are very different despite similar volume contents. This cannot be attributed only to the influence of the various cooling velocites or to the various temperature intervals in the miscibility gap. It is apparently due to surface and interfacial tensions in the structure of specimens. ESA

N91-22910# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Inst. fuer Raumsimulation.
NUCLEATION IN UNDERCOOLED SILVER-GERMANIUM ALLOYS
Yao Ji Wang (Academia Sinica, Beijing, China) *In its* Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 183-189 (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The formation and evolution of the eutectic solidification is studied in the simple eutectic system of binary silver germanium alloy. A high frequency induction heating furnace with Xt recorder and Differential Thermal Analysis (DTA) were used as measurement systems in the investigation. Using a flux of B2O3 on the AgGe system, undercooling of approximately greater than 100 K was obtained for primary nucleation and eutectic transitions respectively. The difference in microstructure between the samples solidified with and without deep undercooling and primary nucleation is shown. ESA

N91-22911# Freiburg Univ. (Germany, F.R.). Inst. fuer Kristallographie.
THE HEATER UNIT OF THE ZONE MELTING FACILITY (ZMF): A RESISTANCE HEATED TEN ZONE FURNACE [DIE HEIZEREINHEIT DES ZMF (ZONE MELTING FACILITY): EIN WIDERSTANDSBEHEIZTER ZEHNZOENOFEN] **c29**
R. Schwarz *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 191-192 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The Zone Melting Facility (ZMF) was designed as a modular growth unit for terrestrial operation and for further use under reduced gravity in a Spacelab or Columbus experimental plant.

The ZMF heater is described. The flexible use of the heating zones allows the adjustment of very flat temperature gradients up to steep profiles. Such a profile is shown for corundum. The ZMF is shown to be a growing unit with which, for small power consumption, growing conditions can be adjusted. ESA

N91-22912# Karlsruhe Univ. (Germany, F.R.). Kristall- und Materiallabor.
CRYSTAL GROWTH IN KARLSRUHE [KRISTALLZUECHTUNG IN KARLSRUHE]
Robert W. Koch *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 193-196 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

The tasks of the laboratory for crystals and materials are presented. Monocrystal growth, characterization, and growth kinetics were studied. A lecture given on the measurement of diffusion coefficients under weightlessness, using shear cell techniques is summarized. As a result, the diffusion coefficients, with reference to various growing concentrations and temperatures, are determined for several binary and ternary systems. ESA

N91-22913# Zentrum fuer Angewandte Raumfahrttechnologie und Mikronavigation, Bremen (Germany, F.R.).
ZARM: GENERAL INFORMATION [ZARM: ALLGEMEINE INFORMATION] **c29**
W. Guenther *In* DLR, Fourth Summer School on Microgravity: Conference Summaries and Forum Lectures Aug. 1990 p 197-202 In GERMAN (For primary document see N91-22883 14-76)
Avail: NTIS HC/MF A10

ZARM is the German acronym for Center for Applied Space Technology and Microgravity. An operational description of a drop tower is given. This tower allows short time experimentation under weightlessness. Bremsat, a low cost university satellite is described. Its scientific objects are the measurement of the thermal conductivity of light viscous fluids under weightlessness, micrometeorites and dust flow in low terrestrial orbit, acceleration, surface interaction, and pressure and temperature during reentry. ESA

N91-22914# Technische Univ., Eindhoven (Netherlands).
ON 1/F NOISE IN THE OPTICAL OUTPUT OF 3-5 DEVICES Ph.D. Thesis
Robert Jan Fronen 1990 98 p
(ISBN-90-9003705-5; ETN-91-99173) Avail: NTIS HC/MF A05

A basic model to explain the observed 1/f noise in the output of several types of semiconductor lasers is presented. Possible electron density fluctuations in a PIN structure are discussed. The mobility fluctuations in the intrinsic region are stated as inducing fluctuations in the number of free electrons and holes, although the effect is slight for a short intrinsic region of a laser. The model is extended to include lasers having different mirror reflectivities. The wavelength dependence of the 1/f noise in the input power is studied experimentally. Proof of the dependence of the 1/f noise on the noncoherent emission in the laser operating region is given. The calculation and its experimental verification of the coherence between the 1/f noise in the two output beams of a laser are described. The 1/f noise in the output of a semiconductor laser amplifier is investigated. The main conclusion of the study is that the 1/f noise in the emission intensity of optoelectronic devices can be interpreted as fluctuations in the absorption coefficient as well as fluctuations in electron concentration. ESA

N91-22915# Technische Univ., Eindhoven (Netherlands).
THE MAGNETIC BEHAVIOR OF DILUTED MAGNETIC SEMICONDUCTORS Ph.D. Thesis
Henricus Johannes Ma Swagten 1990 115 p Sponsored by Stichting voor Fundamenteel Onderzoek der Materie
(ETN-91-99174) Avail: NTIS HC/MF A06

The magnetic properties of Diluted Magnetic Semiconductors (DMS) are discussed. With respect to Mn containing DMS, focus is on the d-d exchange (J) between Mn ions, in particular the strength of J as well as the relevance of long range interactions. A family of DMS containing Fe instead of Mn is introduced and physical effects arising from Fe levels located above the valence bands, which are not populated in the Mn case, are observed. The influence of this on the magnetic properties is discussed. The IV-VI group DMS is introduced. In comparison with II-VI and II-V materials, the carrier concentration in these systems is very high, leading in some cases to ferromagnetic RKKY interactions. The ferromagnetic interactions in Pb(1-x-y)Sn(y)Mn(x)Te and Sn(1-2)Mn(x)Te strongly depend on the carrier density. This phenomena (carrier induced ferromagnetism) is introduced and recent developments are reported. ESA

N91-22916# Technische Univ., Eindhoven (Netherlands). Dept. of Physics.
THE POTENTIAL DISTRIBUTION IN THE QUANTIZED HALL EFFECT Ph.D. Thesis
Petrus Franciscus Fontein 5 Oct. 1990 75 p Sponsored by Netherlands Organization for the Advancement of Pure Research
(ETN-91-99184) Avail: NTIS HC/MF A04

The current distribution under quantized Hall conditions in two dimensional electron gases present in GaAs/Al(x)Ga(1-x)As heterostructures is investigated. The determination and calculation of the current distribution in inhomogeneous two dimensional electron systems is presented. It is argued that inhomogeneities can strongly influence the current distribution in high magnetic fields and it is shown that this can lead to specific structure in the Shubnikov-de Haas minima and to asymmetrical Shubnikov-de Haas peaks. The occurrence of quantized Hall plateaus is calculated for different types of sample inhomogeneities. Spatially resolved measurements of the potential distribution using an optical technique are presented. The potential distribution is shown to be determined by edge charge, which results in step changes of the Hall potential at the edges. The influence of the presence of sample edges on the occurrence of the quantized Hall effect is investigated on a Corbino disc subjected to a magnetic field. The Hall conductance of the Corbino disc is determined and the presence of inhomogeneities is found to cause the plateaus to disappear, in contrast to what is observed in Hall bar structures. ESA

N91-22917# Los Alamos National Lab., NM.
VALENCE-FLUCTUATION SCENARIO FOR CUPRATE SUPERCONDUCTIVITY: THE FINITE-U PAIRING MECHANISM
B. H. Brandow 1991 9 p Presented at the Electronic Structure and Mechanisms for High Temperature Superconductivity, Coral Gables, 3-9 Jan. 1991
(Contract W-7405-eng-36)
(DE91-009953; LA-UR-91-893; CONF-910145-2) Avail: NTIS HC/MF A02

The ideal that the normal state of cuprate superconductors is a valence-fluctuation (VF) state is appealing for a number of reasons. We are exploring this scenario quantitatively, focussing especially on the finite-U mechanism for s-wave pairing. The calculations employ a many-body variational technique developed previously for VF and heavy-fermion materials. We are presently exploring the effects of (1) varying the Hamiltonian parameters away from the values obtained from photoemission data analysis, (2) various simple assumptions for the band structure and hybridization k-dependence, and (3) corrections and to the Gutzwiller approximation. These are the topics to be discussed in this report. DOE

N91-22918# Los Alamos National Lab., NM.
QUASI-TWO DIMENSIONAL DENSITY OF STATES AND THE ISOTOPE EFFECT IN THE SUPERCONDUCTING Cu OXIDES
D. Coffey, R. Schwarz, and P. Yvon 1991 4 p Presented at the Conference on Fermiology of High Tc Superconductors, Argonne, 25-27 Mar. 1991
(Contract W-7405-eng-36)

(DE91-009969; LA-UR-91-1013; CONF-9103112-1) Avail: NTIS HC/MF A01

Tsuei et al. have pointed out that the correlation between a maximium in (Tc) and a minimum in the oxygen isotope exponent, alpha, observed by Crawford et al. in La(2-x)Sr(x)CuO4 and by Franck et al. in (Y(1-x)Pr(x))Ba2Cu3O7 may be understood as a carrier density of states effect, N(E). We point out here that, if the gap equation is treated in the weak coupling approximation, an N(E) with an enhancement in a narrow range of energies which is symmetric about some energy E(sub s) is sufficient to give the correlation. We discuss how such as enhancement may arise from a tight-binding description of the CuO planes. DOE

N91-22919# Argonne National Lab., IL.
PRACTICAL SUPERCONDUCTOR DEVELOPMENT FOR ELECTRICAL POWER APPLICATIONS
K. C. Goretta, comp. Oct. 1990 41 p
(Contract W-31-109-eng-38)
(DE91-010015; ANL-90/47) Avail: NTIS HC/MF A03

Development of useful high-critical-temperature (high-(Tc)) superconductors requires synthesis of superconducting compounds; fabrication of wires, tapes, and films from these compounds; production of composite structures that incorporate stabilizers or insulators; and design and testing of efficient components. This report describes technical progress of research and development efforts aimed at producing superconducting components based on the Y-Ba-Ca, Bi-Sr-Ca-Cu, Bi-Pb-Sr-Ca-Cu, and Tl-Ba-Ca-Cu oxide systems. Topics discussed are synthesis and heat treatment of high-(Tc) superconductors, formation of monolithic and composite wires and tapes, superconductor/metal connectors, characterization of structures and superconducting and mechanical properties, and fabrication and properties of thin films. Collaboration with industry and academia is also documented. DOE

N91-22920# Argonne National Lab., IL.
DIFFUSION IN YBa2Cu3O7-(DELTA)
S. J. Rothman, Nan Chen, and J. L. Routbort Jan. 1991 13 p Presented at the High-temperature Superconductors: Processing and Microstructure Property Relationships, New Orleans, 17-21 Feb. 1991
(Contract W-31-109-eng-38)
(DE91-010268; ANL/CP-70841; CONF-910212-3) Avail: NTIS HC/MF A03

This paper presents a review of diffusion data in YBa2 Cu3 O sub 7-(delta) including tracer and chemical diffusion of oxygen and tracer diffusion Cu. New results on the diffusion of Ba, Y, and some rare earths, Dy, Ho, Gd are also presented. The activation energies are compared with those for sintering and creep. Some diffusion results deduced from the interaction between YBa2 Cu3 O sub 7-(delta) thin films and various substrates are discussed. DOE

N91-22921*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DEVELOPMENT OF SILICON CARBIDE SEMICONDUCTOR DEVICES FOR HIGH TEMPERATURE APPLICATIONS
Lawrence G. Matus, J. Anthony Powell, and Jeremy B. Petit (Sverdrup Technology, Inc., Brook Park, OH.) 1991 9 p Presented at the First International High Temperature Electronics Conference, Albuquerque, NM, 16-2 0 Jun. 1991; sponsored by Sandia National Labs., AF Wright Research and Development Center, and New Mexico Univ.
(NASA-TM-104398; E-6217; NAS 1.15:104398) Avail: NTIS HC/MF A02 CSCL 20L

The semiconducting properties of electronic grade silicon carbide crystals, such as wide energy bandgap, make it particularly attractive for high temperature applications. Applications for high temperature electronic devices include instrumentation for engines under development, engine control and condition monitoring systems, and power conditioning and control systems for space platforms and satellites. Discrete prototype SiC devices were fabricated and tested at elevated temperatures. Grown p-n junction diodes demonstrated very good rectification characteristics at 870 K. A depletion-mode metal-oxide-semiconductor field-effect transistor was also successfully fabricated and tested at 770 K. While optimization of SiC fabrication processes remain, it is believed that SiC is an enabling high temperature electronic technology. Author

N91-22179*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
APPLICATIONS OF THIN FILM TECHNOLOGY TOWARD A LOW-MASS SOLAR POWER SATELLITE
Geoffrey A. Landis (Sverdrup Technology, Inc., Brook Park, OH.) and Ronald C. Cull *In its* Vision-21: Space Travel for the Next Millennium Apr. 1990 p 494-500 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 20L

77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

N91-22922 California Univ., Santa Barbara.
SLOW MOTION APPROXIMATIONS IN GENERAL RELATIVITY Ph.D. Thesis
Robert Craig Ferrell 1989 171 p
Avail: Univ. Microfilms Order No. DA9029548

Interactions of slowly moving, nonrotating, maximally charged black holes are studied. The slow motion approximation allows both gravitational and electromagnetic radiation in the spacetime to be neglected. Maximally charged black holes induce only small, velocity dependent, forces on one another so the analysis is valid even when the black holes approach each other closely. In the approximating spacetime, the spacetime is foliated with a sequence of spacelike 3-D slices, and it is assumed that on any given slice the gravitational and electromagnetic fields are determined entirely in terms of the positions and velocities of the black holes. The relations between the fields and the black holes are slow motion approximations to the initial value equations of general relativity and of electromagnetism. The motion of black holes is found from an effective action which is the usual action for the coupled gravitational-electromagnetic system, but with the fields 'integrated out'. Both scattering orbits and orbits which result in coalescence of the two black holes are found. The quantum mechanical scattering of slowly moving maximimally charged black holes is described. A canonical quantization procedure on the space of possible static classical solutions is also described. The capture coefficients for the scattering of two black holes is computed. How quantization on moduli space relates to quantization of the degress of freedom of the gravitational field is discussed. An effective Langrangian for slowly moving, parallel cosmic strings interacting only through gravity is derived. A simple and constructive analytical derivation of the N-body interaction is provided. Finally, gravitational radiation from boson stars is discussed. Dissert. Abstr.

N91-22923# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
BRST COHOMOLOGY AND BRST GAUGE FIXING
W. Kalau (Wuppertal Univ., Germany, F.R.) and J. W. vanHolten 1991 26 p Sponsored by Stichting voor Fundamenteel Onderzoek der Materie
(NIKHEF-H/91-04; ETN-91-99135) Avail: NTIS HC/MF A03

Some general aspects of BRST cohomology are discussed. The BRST gauge fixing procedure based on the harmonic gauges in the ghost extended quantum mechanical Hilbert space is investigated. A general classification of states according to their BRST transformation properties is obtained. On the basis of these results necessary and sufficient conditions for the positivity of the

physical state space following an ealier analysis of Spiegelglas are found. The method is applied to a system with a nonsimple, solvable algebra of first class constraints, such as appears in the theory of massless higher spins. It was found that both the Dirac and Gupta-Bleuler quantization procedures are contained within the BRST approach. ESA

N91-22924# Leiden Univ. (Netherlands). Div. of Applied Mathematics.
MAXIMUM NORM CONTRACTIVITY OF DISCRETIZATION SCHEMES FOR THE HEAT EQUATION
J. F. B. M. Kraaijevanger 1990 19 p Sponsored by Royal Netherlands Academy of Arts and Sciences, Amsterdam
(TW-90-06; ETN-91-99147) Avail: NTIS HC/MF A03

A necessary and sufficient condition for maximum norm contractivity of a large class of discretization methods for solving the heat equations previously obtained is studied. Specializing this result for the well known Crank-Nicolson method the criterion delta t/(delta x) squared is less than or equal to 3/2, which is less restrictive than the weakest presently available sufficient condition delta t/(delta x) squared is less than or equal to 1 is arrived at. A comparison is made with other stability criteria and with sufficient conditions which are based on the concept of absolute monotonicity. The construction of some optimal explicit schemes are presented in the conclusion. ESA

N91-22925# Washington Univ., Seattle. Dept. of Physics.
BIAXIAL BIANCHI TYPE 9 QUANTUM COSMOLOGY
L. G. Jensen, J. Louko, and P. J. Ruback Apr. 1990 13 p
(Contract DE-AS06-88ER-40423)
(DE91-009610; DOE/ER-40423/06-P90; CERN-TH-5618/90)
Avail: NTIS HC/MF A03

We investigate the quantum cosmology of spatially homogeneous models with compact spatial sections admitting a u(2) isometry algebra. The metric ansatz in these models is that of Bianchi type IX with two scale factors set to be equal. We apply the Hartle-Hawking no-boundary path integral prescription and find the semi-classical contributions to the wave function. Exact formulae are obtainable for certain contributions and otherwise the limits of large and small anisotropy (for the pure vacuum case) and large spatial volume or small anisotropy (for the case with a positive cosmological constant) are considered. For the pure vacuum case we find no semiclassical components which would correspond to Lorentzian universes. For the case with a cosmological constant the Hartle-Hawking boundary conditions formally constrain one of the parameters in the Lorentzian solutions to be purely imaginary. Possible interpretations of this imaginary parameter are discussed. DOE

80 SOCIAL SCIENCES (GENERAL)

Includes educational matters.

N91-22926*# Old Dominion Univ., Norfolk, VA. Inst. for Computational and Applied Mechanics.
NASA LANGLEY RESEARCH CENTER HBCU/OMU PROGRAM: 1990 STUDENT SUPPORT SURVEY Summary Report
R. L. Yang and Surendra N. Tiwari Apr. 1991 20 p
(Grant NAG1-363)
(NASA-CR-188149; NAS 1.26:188149; ODU/ICAM-91-101)
Avail: NTIS HC/MF A03 CSCL 05I

The results of a survey of students who are receiving support through the Historically Black Colleges and Universities and Other Minority Universities are given. Information is given on the race, sex, ethnic distribution, grade point average distribution, and target degree distribution. Author

81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

N91-22927# Small Business Administration, Washington, DC.
STATE OF SMALL BUSINESS: A REPORT TO THE PRESIDENT, TRANSMITTED TO THE CONGRESS JANUARY 1990, TOGETHER WITH THE ANNUAL REPORT ON SMALL BUSINESS AND COMPETITION OF THE US SMALL BUSINESS ADMINISTRATION
Oct. 1990 300 p
(PB91-130849) Avail: NTIS HC/MF A13; also available SOD HC $8.50 as 045-000-00260-8 CSCL 05A

The current economic climate for small businesses, including job creation, business formation, earnings, failure and bankruptcy rates, and the outlook for new and small businesses is presented. GRA

N91-22928*# National Aeronautics and Space Administration, Washington, DC.
THE OFFICE OF SPACE SCIENCE AND APPLICATIONS STRATEGIC PLAN, 1990: A STRATEGY FOR LEADERSHIP IN SPACE THROUGH EXCELLENCE IN SPACE SCIENCE AND APPLICATIONS
1990 70 p
(NASA-TM-104950; NAS 1.15:104950) Avail: NTIS HC/MF A04 CSCL 05A

A strategic plan for the U.S. space science and applications program during the next 5 to 10 years was developed and published in 1988. Based on the strategies developed by the advisory committees of both the National Academy of Science and NASA, the plan balances major, moderate, and small mission initiatives, the utilization of the Space Station Freedom, and the requirements for a vital research base. The Office of Space Science and Applications (OSSA) strategic plan is constructed around five actions: establish a set of programmatic themes; establish a set of decision rules; establish a set of priorities for missions and programs within each theme; demonstrate that the strategy will yield a viable program; and check the strategy for consistency within resource constraints. The OSSA plan is revised annually. This OSSA 1990 Strategic Plan refines the 1989 Plan and represents OSSA's initial plan for fulfilling its responsibilities in two major national initiatives. The Plan is now built on interrelated, complementary strategies for the core space science and applications program, for the U.S. Global Change Research Program, and for the Space Exploration Initiative. The challenge is to make sure that the current level of activity is sustained through the end of this century and into the next. The 1990 Plan presents OSSA's strategy to do this. B.G.

82 DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.

For computer documentation see *61 Computer Programming and Software.*

N91-22929# American Association for the Advancement of Science, Washington, DC.
ABSTRACTS OF PAPERS
Michelle D. Games, Comp. Feb. 1991 173 p Presented at the 157th Annual Meeting of AAAS, Washington DC, 14-19 Feb. 1991
Avail: NTIS HC/MF A08

Abstracts of research in various fields are given. Subject areas include computers, energy technology, particle physics, astronomy, climate change, environment protection, cell biology, health, agriculture, ecology, biological evolution, biomedical ethics,

psychology, anthropology, archaeology, political science, sociology, economics, arms control, technology policy, and science education. Author

N91-22930# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Laboratorio Associado de Computacao e Matematica Aplicada.
A HYBRID KNOWLEDGE REPRESENTATION TOOL
Gilherme Bittencourt Nov. 1990 14 p Presented at the 7th Brazilian Symposium on Artificial Intelligence, Campina Grande, Brazil, 12-16 Nov. 1990
(INPE-5195-PRE/1663) Avail: NTIS HC/MF A03

A system is described for hybrid knowledge representation. The system supports three different knowledge representation formalisms: First-order logic, terminological language, and semantic networks. The first-order logic formalism allows the representation of assertional knowledge in the form of logic formulae, and the calculation of the entailment relation, a weaker but decidable form of logic implication. The terminological language allows the definition of concepts and relations through the use of description primitives. This formalism also supports the calculation of subsumption between entity descriptions. Finally, the semantic network formalism allows the definition of hierarchies of classes and the calculation of inheritance with exceptions, according to the skeptical strategy. The system also supports hybrid inferences taking into account the knowledge represented in different formalisms. All the algorithms involved in the inferences supported by the system are decidable, and according to a four-valued semantic definition, sound, and complete. The system was implemented in Common Lisp. Author

N91-22931*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NASA/DOD AEROSPACE KNOWLEDGE DIFFUSION RESEARCH PROJECT. PHASE 2: RESPONDENTS INCLUDING FREQUENCY DISTRIBUTIONS Summary Report no. 7
Thomas E. Pinelli, John M. Kennedy, and Terry F. White (Indiana Univ., Bloomington.) Mar. 1991 40 p
(NASA-TM-104063; NAS 1.15:104063) Avail: NTIS HC/MF A03 CSCL 05B

Phase 2 of the four phase NASA/DoD Aerospace Knowledge Diffusion Research Project was undertaken to study the transfer of scientific and technical information (STI) from government to the aerospace industry and the role of librarians and technical information specialists in the transfer process. Data was collected through a self-administered mailback questionnaire. Libraries identified as holding substantial aerospace or aeronautical technical report collections were selected to receive the questionnaires. Within each library, the person responsible for the technical report was requested to answer the questionnaire. Questionnaires were returned from approx. 68 pct. of the libraries. The respondents indicated that scientists and engineer are not aware of the services available from libraries/technical information centers and that scientists and engineers also under-utilized their services. The respondents also indicated they should be more involved in the process. Author

N91-22932 Stanford Univ., CA.
VIEW OBJECTS FOR RELATIONAL DATABASES Ph.D. Thesis
Theirry Barsalou 1990 332 p
Avail: Univ. Microfilms Order No. DA9102225

Many application domains require database techniques for modeling and managing entities of arbitrary structure: the so-called complex objects. At the same time, a major incentive to exploit database management systems is the ability to support sharing of data among applications. In practice, however, these two objectives tend to conflict. Storing information in the form of complex objects can seriously inhibit sharing, since persistent objects bind application-dependent knowledge to the data. On the other hand, the relational model provides information sharing through, for example, the definition of views, but it lacks the expressive power to represent complex entities. The view-object model is presented as a first step toward reconciling the opposing objectives of object-oriented access to shared information. By combining the relational-database concept of view and the programming-language concept of object, the view-object model supports simultaneously abstract complex units of information and sharing of those units. Base information remains stored in a fully normalized relational database; this regular representation facilitates sharing. View objects are defined by complex, arbitrary structures that map cleanly to the underlying database through the use of a semantic data model, the structural model. Hence, multiple view objects, specified over various parts of the database, offer different views of the data. Dynamic instantiation and update operations on view objects further support object-oriented manipulation of the information. In effect, the view-object model provides a unifying framework for merging database and knowledge-based techniques into an architecture for expert database systems. This methodology is implemented in a prototype system called PENGUIN, which defines an object layer on top of a relational database system. Dissert. Abstr.

N91-22933# General Accounting Office, Washington, DC.
SPACE DATA: NASA'S FUTURE DATA VOLUMES CREATE FORMIDABLE CHALLENGES
Apr. 1991 29 p
(GAO/IMTEC-91-24; Rept-B-240617) Avail: NTIS HC/MF A03

NASA has several initiatives underway to handle the processing and storage of future space and earth science data that will be generated at unprecedented rates and volumes. NASA believes that current initiatives in advanced storage media and in programs such as Customer Data and Operations Systems (CDOS) and Earth Observing System Data Information System (EOSDIS), combined with other initiatives, will meet future demands to process and store the expected deluge of data. CDOS and EOSDIS are information technology initiatives critical to NASA's ability to efficiently and economically process, analyze, and store the massive amounts of earth and space science data. However, NASA will face many formidable development challenges before all future processing and storage demands can be met. Author

N91-22934* National Aeronautics and Space Administration, Washington, DC.
NASA LIBRARY PROJECT MANAGEMENT COLLECTION
Apr. 1991 53 p
(NASA-TM-103326; NAS 1.15:103326) Avail: Issuing Activity CSCL 05B

A selection of annotated references to unclassified reports, journal articles, and conference proceeding papers introduced into the NASA scientific and technical information system in Scientific and Technical Aerospace Reports (STAR) and International Aerospace Reports (IAA) are given. Subject areas covered include cost analysis, contract management, engineering management, government procurement, life cycle costs, logistics management, maintainability, management methods, management planning, manpower, mission planning, operations research, personnel management, reliability engineering, scheduling, system effectiveness, systems engineering, and systems management. Author

N91-22935*# National Aeronautics and Space Administration, Washington, DC.
NASA GATEWAY REQUIREMENTS ANALYSIS Final Report
Denise R. Duncan, John S. Doby, and Cynthia W. Shockley Mar. 1991 53 p Prepared in cooperation with Logistics Management Inst., Bethesda, MD
(Contracts MDA903-90-C-0006; PE-0902198D)
(NASA-TM-104951; NAS 1.15:104951; LMI-NS001R1) Avail: NTIS HC/MF A04 CSCL 05B

NASA devotes approximately 40 percent of its budget to R&D. Twelve NASA Research Centers and their contractors conduct this R&D, which ranges across many disciplines and is fueled by information about previous endeavors. Locating the right information is crucial. While NASA researchers use peer contacts as their primary source of scientific and technical information (STI), on-line bibliographic data bases - both Government-owned and

commercial - are also frequently consulted. Once identified, the STI must be delivered in a usable format. This report assesses the appropriateness of developing an intelligent gateway interface for the NASA R&D community as a means of obtaining improved access to relevant STI resources outside of NASA's Remote Console (RECON) on-line bibliographic database. A study was conducted to determine (1) the information requirements of the R&D community, (2) the information sources to meet those requirements, and (3) ways of facilitating access to those information sources. Findings indicate that NASA researchers need more comprehensive STI coverage of disciplines not now represented in the RECON database. This augmented subject coverage should preferably be provided by both domestic and foreign STI sources. It was also found that NASA researchers frequently request rapid delivery of STI, in its original format. Finally, it was found that researchers need a better system for alerting them to recent developments in their areas of interest. A gateway that provides access to domestic and international information sources can also solve several shortcomings in the present STI delivery system. NASA should further test the practicality of a gateway as a mechanism for improved STI access. Author

N91-22936# National Inst. of Standards and Technology, Gaithersburg, MD. National Computer and Telecommunications Lab.

PROCEEDINGS OF THE FEDERAL INFORMATION PROCESSING STANDARDS (FIPS) WORKSHOP ON INFORMATION RESOURCE DICTIONARY SYSTEM (IRDS) APPLICATIONS

Alan Goldfine, ed. Dec. 1988 197 p Workshop held in Gaithersburg, MD, 24-25 Mar. 1988

(PB89-136329; NISTIR-88/3896) Avail: NTIS HC/MF A09 CSCL 05B

This report consists of the user presentations at a workshop on applications of the Information Resource Dictionary System (IRDS) held at the National Bureau of Standards (now the National Institute of Standards and Technology) on March 24-25, 1988. Representatives of twenty Federal Government Agencies discussed current and planned applications of the IRDS at their respective organizations. For individual titles, see N91-22937 through N91-22939.

N91-22937# National Inst. of Standards and Technology, Gaithersburg, MD. Inst. for Computer Sciences and Technology.

GUIDE TO IRDS APPLICATIONS: GENERAL CONCEPTS AND STRATEGIC SYSTEMS PLANNING

Margaret H. Law *In its* Proceedings of the Federal Information Processing Standards (FIPS) Workshop on Information Resource Dictionary System (IRDS) Applications Dec. 1988 p 8-14 (For primary document see N91-22936 14-82)

Avail: NTIS HC/MF A09 CSCL 05B

An information resource dictionary system (IRDS) is a data dictionary system used to design, monitor, protect, and control information systems. The IRDS standard represents federal and national efforts to provide quality data dictionary support for information engineering and management. The extensible schema capabilities of the IRDS permit the representation of a wide variety of CASE, data administration, and other system life cycle information in an Information Resource Dictionary (IRD), an application of the IRDS. Some of the topics covered include: (1) features of the IRDS; (2) predefined schema structures; (3) command language and panel interfaces; (4) extensible life cycle phase facility; (5) security facilities; and (6) strategic systems planning. K.S.

N91-22938# Mitre Corp., Houston, TX.

NASA-JOHNSON SPACE CENTER

Sandra Anderson *In* NIST, Proceedings of the Federal Information Processing Standards (FIPS) Workshop on Information Resource Dictionary System (IRDS) Applications Dec. 1988 p 133-141 (For primary document see N91-22936 14-82)

Avail: NTIS HC/MF A09

The Information Resource Dictionary System (IRDS) is becoming more and more recognized as an integral part of the management of data at Johnson Space Center (JSC). The initial impetus for using a global IRDS came from the Space Station Program (SSP). The IRDS standard was specified in the Technical and Management Information System (TMIS) Request for Proposal (RFP). The TMIS is an SSP-wide information system supporting the technical and administrative needs of the NASA centers, the international partners, and the customers. The focus of this talk is the general use of the IRDS at the JSC. Author

N91-22939# Booz-Allen and Hamilton, Inc., Reston, VA.

NASA-SPACE STATION PROGRAM

Stephen J. Ritzman *In* NIST, Proceedings of the Federal Information Processing Standards (FIPS) Workshop on Information Resource Dictionary System (IRDS) Applications Dec. 1988 p 142-152 (For primary document see N91-22936 14-82)

Avail: NTIS HC/MF A09

This talk concerns the Technical and Management Information System (TMIS) project and issues related to other systems within the Space Station Program (SSP) as well as the impact of the Information Resource Dictionary System (IRDS) on them. Some of the topics discussed include: (1) information management; (2) program management; (3) software development; (4) the Space Station Information System; (5) the TMIS; (6) information transfer systems; (7) the three characteristics of the information resources that are going to exist in the different system domains; and (8) interoperability, data transportability, and commonality. K.S.

N91-22940# Assistant Secretary of the Air Force, Washington, DC. Deputy Director for Scienific and Technical Information.

DOCUMENT MARKING

Walter R. Blados, Allan D. Kuhn, and Charlie Maiorana Apr. 1990 24 p Prepared in cooperation with INFO/tek, Washington, DC

(AD-A231150; USAF-STINFO-Management-90/4; SAF/AQT-SR-90-004) Avail: NTIS HC/MF A03 CSCL 05/2

This document describes the DoD document marking system. The two basic purposes are discussed: (1) to identify documents that contain export-controlled information (the dissemination of which is set by statute); and (2) to facilitate dissemination by explicitly indicating the extent of secondary distribution permissible without further authorization by the originator. This document provides summary information about the Technical Document Distribution Program and the Export-Control Program which are two separate and distinct programs. This document may be used in conjunction with its companion video, or separately. GRA

N91-22941# Colorado State Univ., Fort Collins. Dept. of Computer Science.

JANUS: INTEGRATING HYPERTEXT WITH A KNOWLEDGE-BASED DESIGN ENVIRONMENT Interim Report, Sep. 1986 - Aug. 1988

Gerhard Fischer, Raymond McCall, and Anders Morch Jul. 1990 17 p

(Contract MDA903-86-C-0143)

(AD-A231773; ARI-RN-90-58) Avail: NTIS HC/MF A03 CSCL 12/7

Hypertext systems and other complex information stores offer little or not guidance for users who need to find useful information. Most users are not interested in exploring a hypertext information space, but in obtaining information to solve problems or accomplish tasks. As a step toward helping users find information, we have developed the JANUS design environment. JANUS allows designers to construct artifacts in the domain of architectural design and, at the same time, to be informed about the principles of design and the reasoning underlying them. The process integrates two design activities: construction and argumentation. Construction is supported by a knowledge based graphic design environment and argumentation is supported by a hypertext system. Our empirical evaluations of JANUS and its predecessors show that integrated support for construction and argumentation is necessary for full support of design. GRA

N91-22942# Systems Exploration, Inc., Dayton, OH.
INTEGRATED MAINTENANCE INFORMATION SYSTEM (IMIS) DIAGNOSTIC MODULE REDESIGN Final Report, Aug. 1989 - Sep. 1990
Garth Cooke, Nicola Maiorana, and Theodore Myers Dec. 1990 129 p
(Contract F33615-88-C-0004)
(AD-A231810; AFHRL-TR-90-79) Avail: NTIS HC/MF A07
CSCL 12/7

This technical report describes Research and Development efforts to redesign and enhance the Integrated Maintenance Information System Diagnostic Module (MIS-DM). The diagnostic module, redesigned in Smalltalk/V and utilizing information from the Content Data Model (CDM), provides technical support to the maintenance technician by furnishing a wide range of capabilities to assist in the selection of an efficient sequence of maintenance tasks. Object-Oriented (OO) rapid prototyping techniques were used to create a diagnostic module compatible with hierarchical data base concepts employed by the CDM. The enhanced IMIS diagnostic module now provides three modes of assessment (functional, physical, and degraded) whereas the previous version provided only the functional mode. Other IMIS diagnostic module enhancements further expanded diagnostic capabilities with the implementation of algorithms to provide an access group option, 'But Not' data entry, presentation of test results, and a revised critically function. GRA

N91-22943# Georgia Inst. of Tech., Atlanta.
RESEARCH DIRECTIONS IN DATABASE SECURITY, 2 Final Report, Jul. - Nov. 1989
Teresa A. Lunt Nov. 1990 196 p Prepared in cooperation with SRI International, Menlo Park, CA
(Contract F30602-88-D-0025)
(AD-A231878; RADC-TR-90-268) Avail: NTIS HC/MF A09
CSCL 12/8

This report describes the final results of a workshop on database security held 15-18 May 1989 in Bethlehem New Hampshire. The workshop featured several short presentations on technology areas including trusted applications, security checking with Prolog extensions, inference/aggregation, auditing, Discretionary Access Control and operating system support. Vender activities and new product developments in multilevel secure database management systems technology were also presented. Finally, a major portion of the workshop was devoted to discussion and presentation of database design alternatives for multilevel systems with emphasis on graphical presentation, inference/aggregation, context and content-dependent classification, and modeling of classification constraints. GRA

N91-22944# National Archives and Records Service, Washington, DC. Archival Research and Evaluation Staff.
OPTICAL DIGITAL IMAGE STORAGE SYSTEM
William L. Hooton, Barry S. Roginski, and Michael A. Goldman Mar. 1991 393 p
Avail: NTIS HC/MF A17

The purpose of the optical digital image storage system (ODISS) project was to demonstrate and evaluate the feasibility of digital imaging, optical disk storage, and computer retrieval technologies as alternative conversion, storage, and retrieval technologies for the National Archives. Among the goals of the project were the following: (1) to establish the feasibility, cost, and benefits of converting paper and microform documents to optical digital media, and to assess document input speeds required to accomplish conversion in an operational environment; (2) to determine the optimal scanning density for documents consistent with producing legible images while minimizing storage requirements; (3) to assess the storage capacity of the system and media in terms of storage cost and efficiency; (4) to evaluate system capability to automatically retrieve stored optical images using electro-mechanical devices; (5) to determine the suitability of creating printed document images from digital data; and (6) to determine staff and public reaction to and acceptance of an image retrieval system as opposed to the paper and microfilm currently used for reference. Author

N91-22945# Groningen Rijksuniv. (Netherlands). Dept. of Computing Science.
A NOTE ON IMPROVING UTILIZATION OF DISK SPACE IN A GENERAL PURPOSE FILE SYSTEM
Coenraad Bron and Eelco J. Dijkstra 26 Nov. 1990 8 p
(CS-9010; ETN-91-99151) Avail: NTIS HC/MF A02

A simple method is described in which the loss of disk space due to internal fragmentation (when the unit of allocation on disk is large in comparison with the mean file size) can be compensated by concatenating groups of files into a single file. The method is summed up as follows: the internal fragmentation of N half blocks for N files can be deduced (on average) to one half block by concatenating these N files into a single file. The method is especially advantageous if the files in these groups are not subject to frequent changes and if the supporting software can conceptually treat such concatenated files as directories. ESA

N91-22946# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Technical Information Panel.
AGARD GUIDE TO AEROSPACE AND DEFENCE TECHNICAL REPORT SERIES IN NATO COUNTRIES
Mar. 1991 420 p Revised
(AGARD-R-743-Rev; ISBN-92-835-0606-5) Copyright Avail: NTIS HC/MF A18; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

A guide is presented to technical reports series relating to aerospace and defense research and development currently published by governments, contractors, research laboratories or universities in NATO member countries. The guide lists reports series from Belgium, Canada, Denmark, Germany, France, Greece, the Netherlands, Norway, Portugal, Spain, United Kingdom, United States, and international organizations. Information given includes a technical report series code, a title (where available), name and address of the organization producing the series, availability (where known), type of organization, and other helpful information provided by the producers. Two indexes are provided: an overall one by number; and one by number within the country. Author

N91-22947# Stanford Linear Accelerator Center, CA.
THE CHEETAH DATA MANAGEMENT SYSTEM
P. F. Kunz and G. B. Word (Rutgers Univ., New Brunswick, NJ.) Mar. 1991 7 p Presented at the 14th Italian National Institute of Nuclear Physics Workshop: Data Structures for Particle Physics Experiments, Erice, Italy, 11-16 Nov. 1990
(Contract DE-AC03-76SF-00515)
(DE91-010290; SU-SLAC-PUB-5450; CONF-9011192-1) Avail: NTIS HC/MF A02

Cheetah is a data management system based on the C programming language. The premise of Cheetah is that the 'banks' of FORTRAN based systems should be 'structures' as defined by the C language. Cheetah is a system to manage these structures, while preserving the use of the C language in its native form. For C structures managed by Cheetah, the user can use Cheetah utilities such as reading and writing, in a machine independent form, both binary and text files to disk or over a network. Files written by Cheetah also contain a dictionary describing in detail the data contained in the file. Such information is intended to be used by interactive programs for presenting the contents of the file. Such information is intended to be used by interactive programs for presenting the contents of file. Cheetah has been ported to many different operating systems with no operating system dependent switches. DOE

N91-23035*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
MONITORING AND ANALYSIS OF DATA FROM COMPLEX SYSTEMS
Thomas Dollman and Kenneth Webster *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar.

1991 p 119-126 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 05B

N91-23036*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
HIGH DATA RATE SYSTEMS FOR THE FUTURE
John Chitwood *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 127-136 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 05B

N91-23037*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
DISTRIBUTED ACCESS VIEW INTEGRATED DATABASE (DAVID) SYSTEM
Barry E. Jacobs *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 137-143 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 05B

83 ECONOMICS AND COST ANALYSIS

Includes cost effectiveness studies.

No abstracts in this category.

84 LAW, POLITICAL SCIENCE AND SPACE POLICY

Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

No abstracts in this category.

85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see also *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

No abstracts in this category.

88 SPACE SCIENCES (GENERAL)

No abstracts in this category.

89 ASTRONOMY

Includes radio, gamma-ray, and infrared astronomy, and astrometry.

N91-22948 Minnesota Univ., Minneapolis.
DEVELOPMENT OF AN EXTREMELY SENSITIVE INFRARED PHOTOMETER FOR THE INVESTIGATION OF DARK MATTER IN GALACTIC HALOS Ph.D. Thesis
James Walter Bergstrom 1990 123 p
Avail: Univ. Microfilms Order No. DA9100923

A general purpose IR photometer utilizing a single-element InSb detector, and a selection of filters and apertures was designed and built. The noise sources for the cryogenically cooled transimpedance preamplifier were identified and measured. The instrument included several especially large aperture for an experiment to investigate the so-called 'dark matter' thought to exist in halos around spiral galaxies. The Ir emission in the halo of edge-on spiral galaxy NGC 4244 was detected at radii exceeding previous measurements. The IR emission at larger galactic radii is consistent with de Vaucouleurs 'r(exp 1/4) law', and the mass-to-light ratio at K is in agreement with previous results showing no evidence of a massive halo consisting of 'substellar objects'. Dissert. Abstr.

N91-22949 Oxford Univ. (England).
HIGH-RESOLUTION STELLAR SPECTROSCOPY Ph.D. Thesis
Jeremy J. Drake 1989 185 p
Avail: Univ. Microfilms Order No. BRD90431

The development in recent years of solid state detectors which enable high resolution stellar spectra of high photometric accuracy to be recorded routinely, and of powerful computational techniques which enable realistic model stellar atmospheres to be calculated and general non-LTE spectral line formation problems to be solved, together with an increasing availability of accurate atomic data, has motivated a series of state-of-the-art spectroscopic analyses and theoretical studies of late-type stars. Broadening parameters arising from collisions between calcium ions and hydrogen atoms were determined for the calcium infrared triplet lines from a detailed analysis of solar disc and solar limb spectra of very high quality. A possible relation between the integrated absorption of the Ca II infrared triplet feature and stellar surface gravity was investigated using a set of model calculations. Detailed simultaneous radiative transfer - statistical equilibrium calculations were undertaken for calcium using model stellar atmospheres corresponding to a variety of spectral types, illustrating non-LTE effects and trends with differing stellar parameters. Particular attention was paid to the photo-ionizing radiation field and to the effects of inelastic collisions with neutral hydrogen atoms. High resolution, low noise spectra of wavelength regions exhibiting neutral calcium lines, for which there exist accurate laboratory atomic data, and lines of neutral and ionized iron were analyzed in two solar-type dwarfs, tau Ceti (G8 V) and eta Ceta (G0 V), in the chromospherically active dwarf epsilon Eri (K2 V), and in the K0 III giant Pollux (beta Gem), to obtain accurate values for the stellar parameters T(sub eff), log g, microturbulence xi, iron abundance relative to the Sun (Fe/H), and calcium abundance Ca/H. The extent of the effects of chromospheric activity on photospheric lines in epsilon Eri was investigated. An empirical LTE model atmosphere was derive for Pollux from the observed profile of the Ca II 8542 A line.
Dissert. Abstr.

N91-22950# Jamieson Science and Engineering, Inc., Scotts Valley, CA.
NEW VERSION OF NASA-AMES/JAMIESON SCIENCE AND ENGINEERING POINT SOURCE INFRARED SKY MODEL Final Technical Report, 13 Jun. 1989 - 12 Oct. 1990
Martin Cohen 8 Jan. 1991 53 p
(Contract F19628-89-C-0116)
(AD-A231953; GL-TR-90-0307) Avail: NTIS HC/MF A04
CSCL 03/1

Our existing Sky Model for the point source infrared sky is extended to make predictions for any filter lying wholly within the range 2, 0 to 35.0 microns. To support this extension we have

developed a library of complete 2 to 35 microns low-resolution (0.1 micron step size) spectra to represent the 87 categories of Galactic object and 4 types of extragalactic source implicit in the Model. This library is based upon the technique of the spectral template whereby existing spectral fragments for individual sources (from ground-based, airborne, and satellite-borne instruments) are combined into complete spectra. Templates provide a natural way of representing the complete spectral energy distributions of celestial sources for which only infrared photometry or partial spectroscopy exists, provided that such sources can be classified by the scheme inherent in the Sky Model which is essentially based upon the combination of optical and mid-infrared attributes. Consequently, templates bear upon the important general problem of establishing mid-infrared calibration sources. The new Model is validated by comparison with broadband K (2.2 microns) source counts. GRA

N91-22951*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
NASA MARSHALL SPACE FLIGHT CENTER SOLAR OBSERVATORY REPORT, JULY - SEPTEMBER 1990
James E. Smith Apr. 1991 74 p
(NASA-TM-103531; NAS 1.15:103531) Avail: NTIS HC/MF A04 CSCL 03A

A description of the NASA Marshall Space Flight C nter's Solar Vector Magnetograph Facility is provided and gives a summary of its observations and data reduction during Jul. - Sep. 1990. The systems that make up the facility are a magnetograph telescope, an H-alpha telescope, a Questar telescope, and a computer code. The data are represented by longitudinal contours with azimuth plots. Author

N91-22952*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
NASA MARSHALL SPACE FLIGHT CENTER SOLAR OBSERVATORY REPORT, OCTOBER - DECEMBER 1990
James E. Smith Apr. 1991 57 p
(NASA-TM-103532; NAS 1.15:103532) Avail: NTIS HC/MF A04 CSCL 03A

A description of the NASA Marshall Space Flight Center's Solar Vector Magnetograph Facility is provided, and a summary of its observations and data reduction during Oct. - Dec. 1990 is presented. The systems that make up the facility are a magnetograph telescope, and H-alpha telescope, a Questar telescope, and a computer code. The data are represented by longitudinal contours with azimuth plots. Author

N91-22953# Technische Univ., Munich (Germany, F.R.). Inst. fuer Mathematik.
AN ALGORITHM FOR DECONVOLUTION BY THE MAXIMUM ENTROPY METHOD WITH ASTRONOMICAL APPLICATIONS
J. Reiter 1990 33 p Sponsored by DFG
(TUM-Rept-229; ETN-91-99254) Avail: NTIS HC/MF A03

The solution of a Fredholm integral equation of the first kind which is, in general, an ill posed problem, can be regularized by the Maximum Entropy Method (MEM), where the solution is reformulated as a nonlinear optimization problem with one or two, repectively, nonlinear constraints. In real life applications, however, this optimization problem is a large scale one with up to 1,000,000 unknowns to be determined. For the solution of such problems, a numerical algorithm which is made to work most efficiently in modern multiprocessor, vector computers is presented. The usefulness of the algorithm is illustrated by deconvolving optical pictures of the sky taken with astronomical telescopes. ESA

90 ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also *75 Plasma Physics*.

N91-22954*# Iowa Univ., Iowa City. Dept. of Physics and Astronomy.
LARGE SCALE MOTIONS OF NEPTUNE'S BOW SHOCK: EVIDENCE FOR CONTROL OF THE SHOCK POSITION BY THE ROTATION PHASE OF NEPTUNE'S MAGNETIC FIELD
Iver H. Cairns, Charles W. Smith, William S. Kurth, Donald A. Gurnett, and Stewart L. Moses (TRW Space Technology Labs., Redondo Beach, CA.) Jan. 1991 65 p
(Grant NAGw-2040)
(NASA-CR-188059; NAS 1.26:188059; UI-91-3) Avail: NTIS HC/MF A04 CSCL 03B

The Voyager 2 spacecraft observed high levels of Langmuir waves before the inbound crossing of Neptune's bow shock, thereby signifying magnetic connection of the bow shock. The Langmuir waves occurred in multiple bursts throughout two distinct periods separated by an 85 minute absence of wave activity. The times of onsets, peaks, and disappearances of the waves were used together with the magnetic field directions and spacecraft position, to perform a 'remote-sensing' analysis of the shape and location of Neptune's bow shock prior to the inbound bow shock crossing. The bow shock is assumed to have a parabolidal shape with a nose location and flaring parameter determined independently for each wave event. The remote-sensing analysis give a shock position consistent with the time of the inbound shock crossing. The flaring parameter of the shock remains approximately constant throughout each period of wave activity but differs by a factor of 10 between the two periods. The absence of waves between two periods of wave activity coincides with a large rotation of the magnetic field and a large increase in the solar wind ram pressure' both these effects lead to magnetic disconnection of the spacecraft from shock. The planetwards motion of the shock's nose from 38.5 R(sub N) to 34.5 R(sub N) during the second time period occurred while the solar wind ram pressure remained constant to within 15 percent. This second period of planetwards motion of the shock is therefore strong evidence for Neptune's bow shock moving in response to the rotation of Neptune's oblique, tilted magnetic dipole. Normalizing the ram pressure, the remotely-sensed shock moves sunwards during the first wave period and planetwards in the second wave period. The maximum standoff distance occurs while the dipole axis is close to being perpendicular to the Sun-Neptune direction. The remote-sensing analysis provides strong evidence that the location of Neptune's bow shock is controlled by Neptune's rotation phase. Author

N91-22955 Stanford Univ., CA.
EVOLUTION OF THE QUASAR DISTRIBUTION, COSMOLOGY, AND THE ACCRETION DISK MODEL OF AGN Ph.D. Thesis
David Merrill Caditz 1990 157 p
Avail: Univ. Microfilms Order No. DA9102236

The relationship between the observed statistical distribution of extragalactic objects, the physical evolution of individual objects, and the cosmological model is discussed. Three simple forms of statistical evolution-pure luminosity evolution (PLE), pure density evolution (PDE), and generalized luminosity evolution (GLE)-are discussed in detail and it is shown that these evolutions imply specific forms of physical evolution. Parametric and nonparametric analyses of the redshift-luminosity distribution for combined samples are developed. The parametric method relies on the moments of the data and can simultaneously determine the evolution of the distribution and the cosmological parameters based on a minimum number of assumptions. The nonparametric method determines the shape of the distribution assuming a cosmological model. The nonparametric method is modified to produce smooth distributions instead of histogram distributions which are sensitive to random fluctuations in the data. Both methods are applied to a combined sample of 265 QSOs with 0.2 is less than z is less

than 2.2 and B is less than 21.1. It is found that PLE and PDE are inconsistent with the data, independent of the choice of cosmological model. GLE may be an adequate description with luminosity evolution of the form L is approximately exp (tau/0.12) where tau is the fractional lookback time, and density decreasing with redshift. QSO physical evolution is predicted using the massive black hole accretion disk model. It is shown that PLE and GLE require a steepening of the UV spectral index, alpha(sub UV), with redshift, if this spectral region is dominated by thermal emission from a hot accretion disk. With reasonable assumptions about the mass accretion rate and initial mass distribution, the statistical evolution may be predicted. It is shown that the spectral steepening may be the cause of the well known kink or break in the slope observed in the quasar luminosity function and that the characteristic double power law shape of the QSO luminosity function is predicted by the accretion disk model. Dissert. Abstr.

N91-22956 Stanford Univ., CA.
COHERENT EMISSION AND STOCHASTIC ACCELERATION PROCESSES ASSOCIATED WITH NONTHERMAL ELECTRONS IN ASTROPHYSICAL PLASMA Ph.D. Thesis
Russell J. Hamilton 1990 208 p
Avail: Univ. Microfilms Order No. DA9102275

Four problems involving wave-particle interactions of nonthermal electrons in astrophysical plasmas are examined. (1) The production of plasma waves by a nonthermal beam of electrons injected into a thick-target thermal plasma is evaluated by solving the coupled kinetic equations for the plasma wave and particle distribution. (2) The correlation of solar hard x-ray and type III radio bursts is examined using statistical methods to analyze tabulated data. (3) A numerical solution of the time dependent kinetic (Fokker-Planck) equation describing the evolution of electron distributions in magnetized plasma is developed. (4) The effects of Coulomb collisions of nonthermal electrons with the ambient plasma in magnetic loops is studied to determine the subsequent effects on the induced cyclotron maser and plasma wave growth. Dissert. Abstr.

N91-22957 Oxford Univ. (England).
COSMOLOGICAL IMPLICATIONS OF SUPERGRAVITY AND SUPERSTRING THEORIES Ph.D. Thesis
Orfeu Bertolami Neto 1987 131 p
Avail: Univ. Microfilms Order No. BRD-90437

The theoretical consistency of the cosmological description that accommodates the salient features of the universe seems to require an early period of exponentially fast expansion or inflation. This can be more naturally obtained within local supersymmetric theories, though these have in turn problems associated with the late release of entropy, and so-called 'entropy crisis', caused by the excess of energy stored in fields lying in the hidden sector and whose interactions are merely gravitational. The aspects of this problem associated with the inflation and the field that accounts for inflation are addressed. It is shown that the merging of the hidden sector responsible for supersymmetry breaking with the one associated with inflation does lead to a severe entropy crisis. The electroweak breaking at finite temperature driven by radiative corrections within the N + 1 supergravity extensions of the standard model are also analyzed, and it is shown that these generalizations of the electroweak theory do not suffer from the sever cosmological supercooling which cause in the corresponding version of the standard model irrecoverable dilution of the baryon asymmetry. Finally, the cosmology of the intermediate gauge symmetry breaking within superstring inspired models is examined, and it is proven that the scale of intermediate breaking needed to account for the particle physics phenomenology is not in conflict with cosmology provided in the latter and early period of inflation intervenes. This inflationary period is also required to inflate away from the horizon domain-walls that are created due to the breaking of discrete symmetries and to dilute the excess of magnetic monopoles possibly generated during the compactification process of the superstring theories. Dissert. Abstr.

N91-22958 Montana State Univ., Bozeman.
EFFECTS OF ELECTRON-POSITRON PAIRS ON ACTIVE GALACTIC NUCLEI Ph.D. Thesis
Bradley Gene Tritz 1990 213 p
Avail: Univ. Microfilms Order No. DA9103072

Electron-positron pair creation is investigated in and around accretion flows within active galactic nuclei. First, two-temperature accretion disk models from the 1970s are re-examined, and the effects of pairs on disk structures are calculated. It is found that thermal pair production produces insufficient pairs to greatly affect the disk, but that nonthermal processes produce sufficient pairs to significantly alter flow structure for a wide range of parameters. Then improvements are made upon earlier studies of pair-induced over-cooling of two-temperature spherical accretion flows. It is found that thermal processes produce insufficient pairs to cause over-cooling; however, nonthermal pair production can be an affective cooling agent. Finally, the origin, vertical structure, and radiation spectrum of steady-state pair cascade atmospheres surrounding accretion flows are investigated, by developing computer codes to model radiative transfer, scattering, pair production, and pair annihilation. It is found that substantial pair atmospheres may develop above accretion flows which emitted even a small fraction of their luminosity as gamma-radiation. The radiation spectrum emitted by the flow may be significantly reprocessed during transit through the atmosphere, leading to interesting observational consequences. The conclusion is reached that under modest and reasonable assumptions, pairs can significantly alter the accretion flows within, and the radiation spectra emitted from, the central engines of active galactic nuclei. Dissert. Abstr.

N91-22959*# Iowa State Univ. of Science and Technology, Ames. Dept. of Physics.
THEORETICAL MODELS OF GAS DYNAMICS AND STAR FORMATION IN INTERACTING RING GALAXIES Final Report, 1 Jan. 1987 - 30 Jun. 1990
Curtis Struck-Marcell 30 Jun. 1990 8 p
(Grant NAGw-1009)
(NASA-CR-188157; NAS 1.26:188157) Avail: NTIS HC/MF A02 CSCL 03B

A series of one and two dimensional hydrodynamic simulations of a ring wave in interstellar gas disks was completed. These calculations included nonlinear source terms to model the effects of interstellar interactions and star formation, as well as the spatial-temporal gas flow. Toomre's kinematical model was merged with the Arnold, Shandarin, and Zeldovich 'pancake' theory of caustics in galaxy formation. The resulting theory can describe almost all the structure in restricted three-body simulations of single-pass collisions, even with multi-component potentials. Off-center galactic collisions were studied to understand the dynamics involved. Multi-color optical and near-infrared observations of faint tidal features were performed in about two dozen interacting galaxies selected from the Arp atlas. This sample provided evidence for ongoing star formation in tidal structures, and even enhancements of star formation in some cases. The task of assembling the data for gas-rich, late-type galaxies, was undertaken to see if a more coherent picture of the gas distribution would emerge from the more complete data. Analytic solutions of the equations with subsonic flows to balance gas consumption for expulsion form a galactic fountain were also derived. B.G.

N91-22960*# National Academy of Sciences - National Research Council, Washington, DC.
PLANETARY SCIENCES: AMERICAN AND SOVIET RESEARCH
Thomas M. Donahue, ed. (Michigan Univ., Ann Arbor.), Kathleen Kearney Trivers, ed., and David M. Abramson, ed. National Academy Press 1991 302 p Workshop held in Moscow, USSR, 2-6 Jan. 1989
(Contract NASw-4383)
(NASA-CR-188165; NAS 1.26:188165; LC-90-62812;
ISBN-0-309-04333-6) Avail: NTIS HC/MF A14 CSCL 03B

Papers presented at the US-USSR Workshop on Planetary Sciences are compiled. The purpose of the workshop was to

examine the current state of theoretical understanding of how the planets were formed and how they evolved to their present state. The workshop assessed the types of observations and experiments that are needed to advance understanding of the formation and evolution of the solar system based on the current theoretical framework. For individual titles, see N91-22961 through N91-22980.

N91-22961*# Massachusetts Univ., Amherst.
THE PROPERTIES AND ENVIRONMENT OF PRIMITIVE SOLAR NEBULAE AS DEDUCED FROM OBSERVATIONS OF SOLAR-TYPE PRE-MAIN SEQUENCE STARS
Stephen E. Strom, Suzan Edwards (Smith Coll., Northampton, MA.), and Karen M. Strom *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 1-16 Sponsored by NASA and NSF (For primary document see N91-22960 14-90)
Avail: NTIS HC/MF A14 CSCL 03B

The following topics were discussed: (1) current observation evidence for the presence of circumstellar disks associated with solar type pre-main sequence (PMS) stars; (2) the properties of such disks; and (3) the disk environment. Author

N91-22962*# Lick Observatory, Santa Cruz, CA.
NUMERICAL TWO-DIMENSIONAL CALCULATIONS OF THE FORMATION OF THE SOLAR NEBULA
Peter H. Bodenheimer *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 17-30 Sponsored in cooperation with NASA. Ames Research Center (For primary document see N91-22960 14-90)
(Grant NSF AST-85-21636)
Avail: NTIS HC/MF A14 CSCL 03B

Numerical two dimensional calculations of the formation of the solar nebula are presented. The following subject areas are covered: (1) observational constraints of the properties of the initial solar nebula; (2) the physical problem; (3) review if two dimensional calculations of the formation phase; (4) recent models with hydrodynamics and radiative transport; and (5) further evolution of the system. Author

N91-22963*# Carnegie Institution of Washington, DC.
THREE-DIMENSIONAL EVOLUTION OF EARLY SOLAR NEBULA
Alan P. Boss *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 31-44 (For primary document see N91-22960 14-90)
(Grants NAGw-1410; NSF AST-85-15644)
Avail: NTIS HC/MF A14 CSCL 03B

The progress is reported toward the goal of a complete theory of solar nebula formation, with an emphasis on three spatial dimension models of solar nebular formation and evolution. The following subject areas are covered: (1) initial conditions for protostellar collapse; (2) single versus binary star formation; (3) angular momentum transport mechanisms; (4) three dimensional solar nebula models; and (5) implications for planetary formation. Author

N91-22964*# Academy of Sciences (USSR), Moscow. Inst. of the Physics of the Earth.
FORMATION AND EVOLUTION OF THE PROTOPLANETARY DISK
Tamara V. Ruzmaikina and A. B. Makalkin *In* NAS-NRC, Planetary Sciences: American and Sovieearch 1991 p 44-60 (For primary document see N91-22960 14-90)
Avail: NTIS HC/MF A14 CSCL 03B

A disk formation model during collapse of the protosolar nebula, yielding a low-mass protoplanetary disk is presented. The following subject areas are covered: (1) circumstellar disks; (2) conditions for the formation of stars with disks; (3) early evolution of the protoplanetary disk; and (4) temperature conditions and the convection in the protoplanetary disk. Author

N91-22965*# Academy of Sciences (USSR), Moscow. Inst. of Geochemistry and Analytic Chemistry.
PHYSICAL-CHEMICAL PROCESSES IN A PROTOPLANETARY CLOUD
Avgusta K. Lavrukhina *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 61-69 (For primary document see N91-22960 14-90)
Avail: NTIS HC/MF A14 CSCL 03B

Physical-chemical processes in a protoplanetary cloud are discussed. The following subject areas are covered: (1) characteristics of the chemical composition of molecular interstellar clouds; (2) properties and physico-chemical process in the genesis of interstellar dust grains; and (3) the isotope composition of volatiles in bodies of the Solar System. Author

N91-22966*# Arizona Univ., Tucson.
MAGNETOHYDRODYNAMIC PUZZLES IN THE PROTOPLANETARY NEBULA
Eugene H. Levy *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 70-81 (For primary document see N91-22960 14-90)
(Grant NsG-7419)
Avail: NTIS HC/MF A14 CSCL 03B

The following subject areas are covered: (1) magnetization of meteorites; (2) the possible origin of a nebular magnetic field; (3) the possibility of magnetic flares; (4) external manifestations; (5) dynamical effects of the magnetic fields; and (6) the problem of ionization. Author

N91-22967*# Planetary Science Inst., Tucson, AZ.
FORMATION OF PLANETESIMALS
Stuart J. Weidenschilling *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 82-97 (For primary document see N91-22960 14-90)
(Contract NASw-4305)
Avail: NTIS HC/MF A14 CSCL 03B

Formation of planetesimals is discussed. The following subject areas are covered: (1) nebular structure; (2) aerodynamics of the solid bodies in the nebula; (3) problems with gravitational instability; (4) particle growth by coagulation; properties of fractal aggregates; and (5) coagulation and settling of fractal aggregates. Author

N91-22968*# Carnegie Institution of Washington, DC.
FORMATION OF THE TERRESTRIAL PLANETS FROM PLANETESIMALS
George W. Wetherill *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 98-115 (For primary document see N91-22960 14-90)
(Grants NsG-7347; NAGw-398)
Avail: NTIS HC/MF A14 CSCL 03B

Formation of the terrestrial planets from planetesimals is discussed. The following subject areas are covered: (1) formation of the original planetesimals; (2) growth of planetesimals into planetary embryos; and (3) growth of runaway planetary embryos into terrestrial planets. Author

N91-22969*# Academy of Sciences (USSR), Moscow. Inst. of the Physics of the Earth.
THE RATE OF PLANET FORMATION AND THE SOLAR SYSTEM'S SMALL BODIES
Viktor S. Safronov *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 116-125 (For primary document see N91-22960 14-90)
Avail: NTIS HC/MF A14 CSCL 03B

The evolution of random velocities and the mass distribution of preplanetary body at the early stage of accumulation are currently under review. Arguments were presented for and against the view of an extremely rapid, runaway growth of the largest bodies at this stage with parameter values of Theta approximately greater than 10(exp 3). Difficulties are encountered assuming such a large Theta: (1) bodies of the Jovian zone penetrate the asteroid zone too late and do not have time to hinder the formation of a normal-sized planet in the asteroidal zone and thereby remove a

significant portion of the mass of solid matter and (2) Uranus and Neptune cannot eject bodies from the solar system into the cometary cloud. Therefore, the values Theta less than 10(exp 2) appear to be preferable. Author

N91-22970*# Minnesota Univ., Minneapolis.
ASTROPHYSICAL DUST GRAINS IN STARS, THE INTERSTELLAR MEDIUM, AND THE SOLAR SYSTEM
Robert D. Gehrz *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 126-142 Sponsored in cooperation with NASA, NSF and AF (For primary document see N91-22960 14-90)
Avail: NTIS HC/MF A14 CSCL 03B

Studies of astrophysical dust grains in circumstellar shells, the interstellar medium, and the solar system may provide information about stellar evolution and about physical conditions in the primitive solar nebula. The following subject areas are covered: (1) the cycling of dust in stellar evolution and the formation of planetary systems; (2) astrophysical dust grains in circumstellar environments; (3) circumstellar grain formation and mass loss; (4) interstellar dust grains; (5) comet dust and the zodiacal cloud; (6) the survival of dust grains during stellar evolution; and (7) establishing connections between stardust and dust in the solar system. Author

N91-22971*# Academy of Sciences (USSR), Moscow. Inst. of the Physics of the Earth.
LATE STAGES OF ACCUMULATION AND EARLY EVOLUTION OF THE PLANETS
Andrey V. Vityazev and G. V. Perchernikova *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 143-162 (For primary document see N91-22960 14-90)
Avail: NTIS HC/MF A14 CSCL 03B

Recently developed solutions of problems are discussed that were traditionally considered fundamental in classical solar system cosmogony: determination of planetary orbit distribution patterns, values for mean eccentricity and orbital inclinations of the planets, and rotation periods and rotation axis inclinations of the planets. Two important cosmochemical aspects of accumulation are examined: the time scale for gas loss from the terrestrial planet zone, and the composition of the planets in terms of isotope data. It was concluded that the early beginning of planet differentiation is a function of the heating of protoplanets during collisions with large (thousands of kilometers) bodies. Energetics, heat mass transfer processes, and characteristic time scales of these processes at the early stages of planet evolution are considered. Author

N91-22972*# California Inst. of Tech., Pasadena. Div. of Geological and Planetary Sciences.
GIANT PLANETS AND THEIR SATELLITES: WHAT ARE THE RELATIONSHIPS BETWEEN THEIR PROPERTIES AND HOW THEY FORMED
David J. Stevenson *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 163-173 (For primary document see N91-22960 14-90)
(Grant NAGw-185)
(Contrib-4686) Avail: NTIS HC/MF A14 CSCL 03B

The following subject areas are covered: (1) the mass distribution; (2) interior models; (3) atmospheric compositions and their implications; (4) heat flows and their implications; (5) satellite systems; (6) temperatures in the solar nebula; and (7) giant planet formation. Author

N91-22973*# Academy of Sciences (USSR), Moscow. Inst. of the Physics of the Earth.
THE THERMAL CONDITIONS OF VENUS
Vladimir N. Zharkov and V. S. Solomatov *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 174-190 (For primary document see N91-22960 14-90)
Avail: NTIS HC/MF A14 CSCL 03B

Models of Venus' thermal evolution are examined. The following subject areas are covered: (1) modified approximation of parameterized convection; (2) description of the model; (3) numerical results and asymptotic solution of the MAPC equations; (4) magnetism and the thermal regime of the cores of Earth and Venus; and (5) the thermal regime of the Venusian crust. Author

N91-22974*# Michigan Univ., Ann Arbor.
DEGASSING
James C. G. Walker *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 191-202 (For primary document see N91-22960 14-90)
(Grant NAGw-176)
Avail: NTIS HC/MF A14 CSCL 03B

Measurements of the concentration of rare gases and trace elements in oceanic basalts provided a new information concerning the structure if the Earth mantle and its evolution. The results set important constraints that need to be incorporated into any comprehensive understanding of the early history of the planets. Some of the highlights of these results are described and an indication is given how they are derived. Author

N91-22975*# Institute of Space Research, Moscow (USSR).
THE ROLE OF IMPACTING PROCESSES IN THE CHEMICAL EVOLUTION OF THE ATMOSPHERE OF PRIMORDIAL EARTH **c45**
Lev M. Mukhin and M. V. Gerasimov *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 203-217 (For primary document see N91-22960 14-90)
Avail: NTIS HC/MF A14 CSCL 13B

The role of impacting processes in the chemical evolution of the atmosphere of primordial Earth is discussed. The following subject areas are covered: (1) Earth's initial atmosphere; (2) continuous degassing; (3) impact processes and the Earth's protoatmosphere; and (4) the evolution of an impact-generated atmosphere. Author

N91-22976*# Academy of Sciences (USSR), Moscow. Inst. of Geochemistry and Analytical Chemistry.
LITHOSPHERIC AND ATMOSPHERIC INTERACTION ON THE PLANET VENUS **c91**
Vladislav P. Volkov *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 218-233 (For primary document see N91-22960 14-90)
Avail: NTIS HC/MF A14 CSCL 03B

Lithospheric and atmospheric interaction in the planet Venus are discussed. The following subject areas are covered: (1) manifestation of exogenic processes using photogeological data; (2) the chemical composition and a chemical model of the troposphere of Venus; (3) the mineral composition of surface rock on Venus; and (4) the cycles of volatile components. Author

N91-22977*# Pennsylvania State Univ., University Park.
RUNAWAY GREENHOUSE ATMOSPHERES: APPLICATIONS TO EARTH AND VENUS **c45**
James F. Kasting *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 234-245 (For primary document see N91-22960 14-90)
Avail: NTIS HC/MF A14 CSCL 13B

Runaway greenhouse atmospheres are discussed from a theoretical standpoint and with respect to various practical situation in which they might occur. The following subject areas are covered: (1) runaway greenhouse atmospheres; (2) moist greenhouse atmospheres; (3) loss of water from Venus; (4) steam atmosphere during accretion; and (5) the continuously habitable zone. Author

N91-22978*# Institute of Space Research, Moscow (USSR).
THE OORT CLOUD
Leonid S. Marochnik, Lev M. Mukhin, and Roald Z. Sagdeev *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 246-258 (For primary document see N91-22960 14-90)
Avail: NTIS HC/MF A14 CSCL 03B

Views of the large-scale structure of the solar system, consisting of the Sun, the nine planets and their satellites, changed when

Oort demonstrated that a gigantic cloud of comets (the Oort cloud) is located on the periphery of the solar system. The following subject areas are covered: (1) the Oort cloud's mass; (2) Hill's cloud mass; (3) angular momentum distribution in the solar system; and (4) the cometary cloud around other stars. Author

N91-22979*# Institute of Space Research, Moscow (USSR).
THE CHAOTIC DYNAMICS OF COMETS AND THE PROBLEMS OF THE OORT CLOUD
Roald Z. Sagdeev and G. M. Zaslavskiy *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 259-269 (For primary document see N91-22960 14-90)
Avail: NTIS HC/MF A14 CSCL 03B

The dynamic properties of comets entering the planetary zone from the Oort cloud are discussed. Even a very slight influence of the large planets can trigger stochastic cometary dynamics. Multiple interactions of comets with the large planets produce diffusion of the parameters of cometary orbits and a mean increase in the semi-major axis of comets. Comets are lifted towards the Oort cloud, where collisions with stars begin to play a substantial role. The transport of comets differs greatly from the customary law of diffusion and noticeably alter cometary distribution. Author

N91-22980*# Space Telescope Science Inst., Baltimore, MD.
PROGRESS IN EXTRA-SOLAR PLANET DETECTION
Robert A. Brown *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 270-287 (For primary document see N91-22960 14-90)
(Contract NAS5-26555)
Avail: NTIS HC/MF A14 CSCL 03B

Progress in extra-solar planet detection is reviewed. The following subject areas are covered: (1) the definition of a planet; (2) the weakness of planet signals; (3) direct techniques - imaging and spectral detection; and (4) indirect techniques - reflex motion and occultations. Author

N91-22981*# Fermi National Accelerator Lab., Batavia, IL.
ASTROPHYSICS AND COSMOLOGY CONFRONT THE 17 keV NEUTRINO
Edward W. Kolb and Michael S. Turner (Chicago Univ., IL.) Feb. 1991 12 p Sponsored by DOE
(Grant NAGw-1340)
(NASA-CR-188169; NAS 1.26:188169; FERMILAB-Pub-91/50-A)
Avail: NTIS HC/MF A03 CSCL 03B

A host of astrophysical and cosmological arguments severely constrain the properties of a 17 keV Dirac neutrino. Such a neutrino must have interactions beyond those of the standard electroweak theory to reduce its cosmic abundance (through decay or annihilation) by a factor of two hundred. A predicament arises because the additional helicity states of the neutrino necessary to construct a Dirac mass must have interactions strong enough to evade the astrophysical bound from SN 1987A, but weak enough to avoid violating the bound from primordial nucleosynthesis. Author

N91-22982*# Fermi National Accelerator Lab., Batavia, IL.
DARK MATTER IN THE UNIVERSE
Michael S. Turner (Chicago Univ., IL.) Mar. 1991 40 p Meeting held in Los Angeles, CA Previously announced as N91-15958 Sponsored in part by DOE
(Grant NAGw-1340)
(NASA-CR-188170; NAS 1.26:188170; FERMILAB-Conf-91/78-A)
Avail: NTIS HC/MF A03 CSCL 03B

What is the quantity and composition of material in the Universe? This is one of the most fundamental questions we can ask about the Universe, and its answer bears on a number of important issues including the formation of structure in the Universe, and the ultimate fate and the earliest history of the Universe. Moreover, answering this question could lead to the discovery of new particles, as well as shedding light on the nature of the fundamental interactions. At present, only a partial answer is at hand. Most of the radiation in the Universe does not give off detectable radiation; it is dark. The dark matter associated with bright galaxies contributes somewhere between 10 and 30 percent of the critical density; baryonic matter contributes between 1.1 and 12 percent of the critical. The case for the spatially flat, Einstein-de Sitter model is supported by three compelling theoretical arguments - structure formation, the temporal Copernican principle, and inflation - and by some observational data. If Omega is indeed unity, or even just significantly greater than 0.1, then there is a strong case for a Universe comprised of nonbaryonic matter. There are three well motivated particle dark matter candidates: an axion of mass 10 (exp -6) eV to 10 (exp -4) eV; a neutrino of mass 10 GeV to about 3 TeV; or a neutrino of mass 20 eV to 90 eV. All three possibilities can be tested by experiments that are either planned or are underway. Author

N91-22983# Washington Univ., Seattle. Dept. of Physics.
A NEW MECHANISM FOR NEUTRALIZING THE COSMOLOGICAL CONSTANT
M. J. Duncan (Minnesota Univ., Minneapolis.) and L. G. Jensen 1991 21 p
(Contracts DE-AS06-88ER-40423; DE-AC02-83ER-40105)
(DE91-009790; DOE/ER-40423/19; UMN-TH-908/90) Avail: NTIS HC/MF A03

We propose a dynamical mechanism for neutralizing the cosmological constant in our universe. The analysis is wholly Lorentzian, unlike most other mechanisms which rely on the problematic Euclidean quantum gravity. Additionally, we do not have to assume any properties of a complete quantum gravity theory for our result. Quantum cosmology is an effective theory below the Planck scale, and it suffices for the purpose of our demonstration. The vacuum energy from particle physics is many orders of magnitude to great to explain the measured smallness of the cosmological constant. Any generic field that allows us to shift the vacuum energy has the possibility of neutralizing it. However, such a field has an infinity of possible vacuum states, and we have to be in exactly the right one to achieve the cancellation. We show that when we third quantize a cosmology containing such a field in its particle physics sector we do have the possibility of selecting one vacuum over another. (The field we use for the sake of demonstration is a four-form.) The essential result of our paper is that the dominant vacuum state for the field is indeed the one that exactly cancels the particle physics vacuum energy. This means that a large universe, such as ours, has a vanishing cosmological constant. DOE

N91-22141*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
INDUSTRIALIZING THE NEAR-EARTH ASTEROIDS: SPECULATIONS ON HUMAN ACTIVITIES IN SPACE IN THE LATTER HALF OF THE 21ST CENTURY
Joel C. Sercel *In* NASA. Lewis Research Center, Vision-21: Space Travel for the Next Millennium Apr. 1990 p 37-53 (For primary document see N91-22139 14-12)
Avail: NTIS HC/MF A25 CSCL 03B

91 LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights. For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

N91-22984*# Lunar and Planetary Inst., Houston, TX.
SCIENTIFIC RESULTS OF THE NASA-SPONSORED STUDY PROJECT ON MARS: EVOLUTION OF VOLCANISM, TECTONICS, AND VOLATILES
Sean C. Solomon, ed., Virgil L. Sharpton, ed., and James R. Zimbelman, ed. (National Air and Space Museum, Washington, DC.) 1990 315 p
(Contract NASw-4066)
(NASA-CR-188056; NAS 1.26:188056; LPI-TR-90-06) Avail: NTIS HC/MF A14 CSCL 03B

The objectives of the Mars: Evolution of Volcanism, Tectonics,

and Volatiles (MEVTV) project are to outline the volcanic and tectonic history of Mars; to determine the influence of volatiles on Martian volcanic and tectonic processes; and to attempt to determine the compositional, thermal, and volatile history of Mars from its volcanic and tectonic evolution. Available data sets were used to test general models of the volcanic and tectonic history of Mars. For individual titles, see N91-22985 through N91-23010.

N91-22985*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE EVOLUTION OF THARSIS: IMPLICATIONS OF GRAVITY, TOPOGRAPHY, AND TECTONICS Abstract Only
W. B. Banerdt and M. P. Golombek *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 63-6 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

Dominating the Western Hemisphere of Mars, the Tharsis rise is an elongate area centered on Syria Planum that ascends as much as 8 to 10 km above the datum. It is intensely fractured by long, narrow grabens that extend radially hundreds of kilometers beyond the rise and is ringed by mostly concentric wrinkle ridges that formed over 2,000 km from the center of the rise. Its size, involving a full hemisphere of Mars, gives it a central role in the thermo-tectonic evolution of the planet and has stimulated a number of studies attempting to determine the sequence of events responsible for this feature. The constraints that gravity and topography data place on the current structure of Tharsis, along with insights into its development derived from comparisons of detailed regional mapping of faulting with theoretical deformation models are reviewed. Finally, a self-consistent model for the structure of Tharsis is proposed. Author

N91-22986*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
MARTIAN IMPACT CRATERS: CONTINUING ANALYSIS OF LOBATE EJECTA SINUOSITY Abstract Only
Nadine G. Barlow *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 65-6 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

The lobate ejecta morphology surrounding most fresh Martian impact craters can be quantitatively analyzed to determine variations in ejecta sinuosity with diameter, latitude, longitude, and terrain. The results of such studies provide another clue to the question of how these morphologies formed: are they the results of vaporization of subsurface volatiles or caused by ejecta entrainment in atmospheric gases. Kargel provided a simple expression to determine the degree of non-circularity of an ejecta blanket. This measure of sinuosity, called 'lobateness', is given by the ratio of the ejecta perimeter to the perimeter of a circle with the same area as that of the ejecta. The Kargel study of 538 rampart craters in selected areas of Mars led to the suggestion that lobateness increased with increasing diameter, decreased at higher latitude, and showed no dependence on elevation or geologic unit. Major problems with the Kargel analysis are the limited size and distribution of the data set and the lack of discrimination among the different types of lobate ejecta morphologies. Bridges and Barlow undertook a new lobateness study of 1582 single lobe (SL) and 251 double lobe (DL) craters. The results are summarized. These results agree with the finding of Kargel that lobateness increases with increasing diameter, but found no indication of a latitude dependence for SL craters. The Bridges and Barlow study has now been extended to multiple lobe (ML) craters. Three hundred and eighty ML craters located across the entire Martian surface were studied. ML craters provide more complications to lobateness studies than do SL and DL craters - in particular, the ejecta lobes surrounding the crater are often incomplete. Since the lobateness formula compares the perimeter of the ejecta lobe to that of a circle, the analysis was restricted only to complete lobes. The lobes are defined sequentially starting with the outermost lobe and moving inward. Author

N91-22987*# Lunar and Planetary Inst., Houston, TX.
OBLIQUITY HISTORIES OF EARTH AND MARS: INFLUENCE OF INERTIAL AND DISSIPATIVE CORE-MANTLE COUPLING Abstract Only
Bruce G. Bills *In its* Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 81-82 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

For both the Earth and Mars, secular variations in the angular separation of the spin axis from the orbit normal are suspected of driving major climatic changes. There is considerable interest in determining the amplitude and timing of these obliquity variations. If the orientation of the orbital plane were inertially fixed, and the planet were to act as a rigid body in it response to precessional torques, the spin axis would simply precess around the orbit at a fixed obliquity and at a uniform angular rate. The precession rate parameter depends on the principal moments of inertia and rotation rate of the perturbed body, and on the gravitational masses and semiminor axes of the perturbing bodies. For Mars, the precession rate is not well known, but probably lies in the interval 8 to 10 arcsec/year. Gravitational interactions between the planets lead to secular motions of the orbit planes. In the rigid body case, the spin axis still attempts to precess about the instantaneous orbit normal, but now the obliquity varies. The hydrostatic figure of a planet represents a compromise between gravitation, which attempts to attain spherical symmetry, and rotation, which prefers cylindrical symmetry. Due to their higher mean densities the cores of the Earth and Mars will be more nearly spherical than the outer layers of these planets. On short time scales it is appropriate to consider the core to be an inviscid fluid constrained to move with the ellipsoidal region bounded by the rigid mantle. The inertial coupling provided by this mechanism is effective whenever the ellipticicy of the container exceeds the ratio of precessional to rotational rates. If the mantle were actually rigid, this would be an extremely effective type of coupling. However, on sufficiently long time scales, the mantle will deform viscously and can accommodate the motions of the core fluid. A fundamentally different type of coupling is provided by electromagnetic or viscous torques. This type of coupling is likely to be most important on longer time scales. In each case, the mantle exerts an equal and opposite torque on the core. Author

N91-22988*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CHARACTERISTICS OF THE MARTIAN ATMOSPHERE SURFACE LAYER Abstract Only
G. D. Clow (Geological Survey, Menlo Park, CA.) and R. M. Haberle *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 111 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

Elements of various terrestrial boundary layer models are extended to Mars in order to estimate sensible heat, latent heat, and momentum fluxes within the Martian atmospheric surface ('constant flux') layer. The atmospheric surface layer consists of an interfacial sublayer immediately adjacent to the ground and an overlying fully turbulent surface sublayer where wind-shear production of turbulence dominates buoyancy production. Within the interfacial sublayer, sensible and latent heat are transported by non-steady molecular diffusion into small-scale eddies which intermittently burst through this zone. Both the thickness of the interfacial sublayer and the characteristics of the turbulent eddies penetrating through it depend on whether airflow is aerodynamically smooth or aerodynamically rough, as determined by the Roughness Reynold's number. Within the overlying surface sublayer, similarity theory can be used to express the mean vertical windspeed, temperature, and water vapor profiles in terms of a single parameter, the Monin-Obukhov stability parameter. To estimate the molecular viscosity and thermal conductivity of a CO2-H2O gas mixture under Martian conditions, parameterizations were developed using data from the TPRC Data Series and the first-order

Chapman-Cowling expressions; the required collision integrals were approximated using the Lenard-Jones potential. Parameterizations for specific heat and binary diffusivity were also determined. The Brutsart model for sensible and latent heat transport within the interfacial sublayer for both aerodynamically smooth and rough airflow was experimentally tested under similar conditions, validating its application to Martian conditions. For the surface sublayer, the definition of the Monin-Obukhov length was modified to properly account for the buoyancy forces arising from water vapor gradients in the Martian atmospheric boundary layer. It was found that under most Martian conditions, the interfacial and surface sublayers offer roughly comparable resistance to sensible heat and water vapor transport and are thus both important in determining the associated fluxes. Author

N91-22989*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

FREE CONVECTION IN THE MATIAN ATMOSPHERE

G. D. Clow (Geological Survey, Menlo Park, CA.) and R. M. Haberle *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 112-113 (For primary document see N91-22984 14-91)

Avail: NTIS HC/MF A14 CSCL 03B

The 'free convective' regime for the Martian atmospheric boundary layer (ABL) was investigated. This state occurs when the mean windspeed at the top of the ABL drops below some critical value U(sub c) and positive buoyant forces are present. Such forces can arise either from vertical temperature or water vapor gradients across the atmospheric surface layer. During free convection, buoyant forces drive narrow plumes that ascend to the inversion height with a return circulation consisting of broad slower-moving downdraughts. Horizontal pressure, temperature, windspeed, and water vapor fluctuations resulting form this circulation pattern can be quite large adjacent to the ground (within the surface layer). The local turbulent fluctuations cause non-zero mean surface stresses, sensible heat fluxes, and latent heat fluxes, even when the mean regional windspeed is zero. Although motions above the surface layer are insensitive to the nature of the surface, the sensible and latent heat fluxes are primarily controlled by processes within the interfacial sublayer immediately adjacent to the ground during free convection. Thus the distinction between aerodynamically smooth and rough airflow within the interfacial sublayer is more important than for the more typical situation where the mean regional windspeed is greater than U(sub c). Buoyant forces associated with water vapor gradients are particularly large on Mars at low pressures and high temperatures when the surface relative humidity is 100 percent, enhancing the likelihood of free convection under these conditions. On this basis, Ingersol postulated the evaporative heat losses from an icy surface on Mars at 237 K and current pressures would exceed the available net radiative flux at the surface, thus prohibiting ice from melting at low atmospheric pressures. Schumann has developed equations describing the horizontal fluctuations and mean vertical gradients occurring during free convection. Schumann's model was generalized to include convection driven by water vapor gradients and to include the effects of circulation above both aerodynamically smooth and rough surfaces. Author

N91-22990*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

MEVTV STUDY: EARLY TECTONIC EVOLUTION OF MARS: CRUSTAL DICHOTOMY TO VALLES MARINERIS

Herbert V. Frey and Richard A. Schultz *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 162-163 (For primary document see N91-22984 14-91)

Avail: NTIS HC/MF A14 CSCL 03B

Several fundamental problems were addressed in the early impact, tectonic, and volcanic evolution of the martian lithosphere: (1) origin and evolution of the fundamental crustal dichotomy, including development of the highland/lowland transition zone; (2) growth and evolution of the Valles Marineris; and (3) nature and role of major resurfacing events in early martian history. The results in these areas are briefly summarized. Author

N91-22991*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

ARE NOACHIAN-AGE RIDGED PLAINS (Nplr) ACTUALLY EARLY HESPERIAN IN AGE Abstract Only

Herbert V. Frey, C. E. Doudnikoff, and A. M. Mongeon *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 164-165 (For primary document see N91-22984 14-91)

Avail: NTIS HC/MF A14 CSCL 03B

Whether or not the Nplr units in Memnonia and Argyre truly represent ridged plains volcanism of Noachian age or are simply areas of younger (Early Hesperian age) volcanism which failed to bury older craters and therefore have a greater total crater age than really applies to the ridged plains portion of those terrains is examined. The Nuekum and Hiller technique is used to determine the number of preserved crater retention surfaces in the Memnonia and Argyre regions where Scott and Tanaka show Nplr units to be common. The results for cratered terrain (Npl) in Memnonia is summarized along with those for ridged plains (Nplr) in both Memnonia and Argyre, and they are compared with similar results obtained for Tempe Terra and Lunae Plunum. Author

N91-22992*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

DOES WRINKLE RIDGE FORMATION ON MARS INVOLVE MOST OF THE LITHOSPHERE

M. P. Golombek, J. Suppe, W. Narr (Princeton Univ., NJ.), J. B. Plescia, and B. Banerdt *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 168-169 (For primary document see N91-22984 14-91)

Avail: NTIS HC/MF A14 CSCL 03B

Recent work on the origin of wrinkle ridges suggests that they are compressional tectonic features whose subsurface structure is not understood. Some characteristics of Martian wrinkle ridges are reviewed which suggest that they are the surface expression of thrust faults that extend through much of the lithosphere. Author

N91-22993*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

VOLATILE COMPOUNDS IN SHERGOTTITE AND NAKHLITE METEORITES Abstract Only

James L. Gooding, Kwesi E. Aggrey, and David W. Muenow (Hawaii Univ., Honolulu.) *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 170-171 Prepared in cooperation with Ramapo Coll. of New Jersey, Mahwah (For primary document see N91-22984 14-91)

Avail: NTIS HC/MF A14 CSCL 03B

Since discovery of apparent carbonate carbon in Nakhla, significant evidence has accumulated for occurrence of volatile compounds in shergotties and nakhlites. Results are presented from a study of volatile compounds in three shergottites, one nakhlite, and three eucrite control samples. Shergotties ALHA77005, EETA79001, and Shergotty, and the nakhlite Nakhla, all contain oxidized sulfur (sulfate) of preterrestrial origin; sulfur oxidation is most complete in EETA79001/Lith-C. Significant bulk carbonate was confirmed in Nakhla and trace carbonate was substantiated for EETA79001, all of which appears to be preterrestrial in origin. Chlorine covaries with oxidized sulfur, whereas carbonate and sulfate are inversely related. These volatile compounds were probably formed in a highly oxidizing, aqueous environment sometime in the late stage histories of the rocks that are now represented as meteorites. They are consistent with the hypothesis that shergottite and nakhlite meteorites originated on Mars and that Mars has supported aqueous geochemistry during its history. Author

N91-22994*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
WEATHERING AND EROSION OF THE POLAR LAYERED DEPOSITS ON MARS Abstract Only
K. E. Herkenhoff *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 176-177 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

The Martial polar layered deposits are widely believed to be composed of water ice and silicates, but the relative amount of each component is unknown. The conventional wisdom among Mars researchers is that the deposits were formed by periodic variations in the deposition of dust and ice caused by climate changes over the last 10 to 100 million years. It is assumed here that water ice is an important constituent of the layered deposits, that the deposits were formed by eolian processes, and that the origin and evolution of the north and south polar deposits were similar. Weathering of the layered deposits by sublimation of water ice can account for the geologic relationships in the polar regions. The nonvolatile components of the layered deposits appears to consist mainly of bright red dust, with small amounts of dark dust or sand. Dark dust, perhaps similar to the magnetic material found at the Viking Lander sites, may perferentially form filamentary residue particles upon weathering of the deposits. Once eroded, these particles may saltate to form the dark dunes found in both polar regions. Author

N91-22995*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AN EFFICIENT AND ACCURATE TECHNIQUE TO COMPUTE THE ABSORPTION, EMISSION, AND TRANSMISSION OF RADIATION BY THE MARTIAN ATMOSPHERE
Bernhard Lee Lindner, Thomas P. Ackerman (Pennsylvania State Univ., University Park.), and James B. Pollack *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 198-200 (For primary document see N91-22984 14-91)
(Contract NASw-4444)
Avail: NTIS HC/MF A14 CSCL 03B

CO2 comprises 95 pct. of the composition of the Martian atmosphere. However, the Martian atmosphere also has a high aerosol content. Dust particles vary from less than 0.2 to greater than 3.0. CO2 is an active absorber and emitter in near IR and IR wavelengths; the near IR absorption bands of CO2 provide significant heating of the atmosphere, and the 15 micron band provides rapid cooling. Including both CO2 and aerosol radiative transfer simultaneously in a model is difficult. Aerosol radiative transfer requires a multiple scattering code, while CO2 radiative transfer must deal with complex wavelength structure. As an alternative to the pure atmosphere treatment in most models which causes inaccuracies, a treatment was developed called the exponential sum or k distribution approximation. The chief advantage of the exponential sum approach is that the integration over k space of f(k) can be computed more quickly than the integration of k sub upsilon over frequency. The exponential sum approach is superior to the photon path distribution and emissivity techniques for dusty conditions. This study was the first application of the exponential sum approach to Martian conditions. Author

N91-22996*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
MARTIAN CRATER COUNTS ON ELYSIUM MONS Abstract Only
Kathleen McBride (Houston Univ., Clear Lake, TX.) and Nadine G. Barlow *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 207 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

Without returned samples from the Martian surface, relative age chronologies and stratigraphic relationships provide the best information for determining the ages of geomorphic features and surface regions. Crater-size frequency distributions of six recently mapped geological units of Elysium Mons were measured to establish their relative ages. Most of the craters on Elysium Mons and the adjacent plains units are between 500 and 1000 meters in diameter. However, only craters 1 km in diameter or larger were used because of inadequate spatial resolution of some of the Viking images and to reduce probability of counting secondary craters. The six geologic units include all of the Elysium Mons construct and a portion of the plains units west of the volcano. The surface area of the units studied is approximately 128,000 sq km. Four of the geologic units were used to create crater distribution curves. There are no craters larger than 1 km within the Elysium Mons caldera. Craters that lacked raised rims, were irregularly shaped, or were arranged in a linear pattern were assumed to be endogenic in origin and not counted. A crater frequency distribution analysis is presented. Author

N91-22997*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
IRON MINERALOGY OF A HAWAIIAN PALAGONITIC SOIL WITH MARS-LIKE SPECTRAL AND MAGNETIC PROPERTIES Abstract Only
Richard V. Morris, James L. Gooding, Howard V. Lauer, Jr., and Robert B. Singer (Arizona Univ., Tucson.) *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 223-224 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

Visible and near-IR spectral data for some palagonitic soils from Mauna Kea, Hawaii, are similar to corresponding spectral data for Mars. It is important to understand the composition, distribution, and mineralogy of the ferric-bearing phases for the best spectral analogues because the correspondence in spectral properties implies that the nature of their ferric-bearing phases may be similar to those on Mars. In order to constrain interpretations of the Martian data, a variety of palagonitic soils should be studied in order to establish to what extent differences in their spectral data correspond to differences in the mineralogy of their ferric-bearing phases. Spectral (350-2100 nm), Mossbauer, magnetic, and some compositional data for one of a suite of Hawaiian palagonitic soils are presented. The soil (HWMK1) was collected below the biologically active zone from the sides of a gully cut at 9000 ft elevation on Mauna Kea. The soil was wet sieved with freon into seven size fractions less than 1 mm.
Author

N91-22998*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
EVOLUTION OF THE OLYMPUS MONS CALDERA, MARS Abstract Only
Peter J. Mouginis-Mark, Mark S. Robinson (Hawaii Univ., Honolulu.), and Maria T. Zuber *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 225-226 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

Extensive high-resolution (15 to 20 m/pixel) coverage of Olympus Mons volcano permits the investigation of the sequence of events associated with the evolution of the nested summit caldera. The sequence of the intra-caldera events is well illustrated by image data collected on orbits 473S and 474S of Viking Orbiter 1. These data cover both the oldest and youngest portions of the caldera floor. The chronology inferred from the observations is presented which in turn can be interpreted in terms of the internal structure of the volcano (i.e., magma chamber depth and the existence of dikes). Author

N91-22999*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
PHOTOCLINOMETRIC ANALYSIS OF WRINKLE RIDGES ON LUNAE PLANUM, MARS Abstract Only
J. B. Plescia *In* Lunar and Planetary Inst., Scientific Results of

the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 241-242 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

Wrinkle ridges are common morphologic features on Mars. Both volcanic and tectonic mechanisms were suggested to explain their origin; recent work has focused on a compressional origin. Analysis of terrestrial analogs has greatly influenced and aided the understanding of wrinkle ridge formation. An important aspect necessary to intrepret structure is topography. Topographic profiles across ridges can provide important constraints for models of internal structure and analyzing deformation associated with ridges. Topographic maps of Mars are too coarse to resolve the topography of individual ridges; therefore, monoscopic photoclinometry was used to derive topographic profiles for the ridges. Profiles spaced a few kilometers apart were obtained for each ridge, the number depended on ridge length, morphology, and albedo variation. Photoclinometry relies on pixel brightness variations which results from topography, albedo, or both. Because of the albedo variations, photoclimometric profiles can not be extended across large distances, such as between adjacent ridges (about 20 to 80 km). However, the technique is applicable to shorter distances, such as the distance across typical ridges. Profiles were measured across the ridge and extended a few kilometers on either side, including all visible components of the ridge. The results of these measurements and the use of internal structure and topographic profile models for estimating the shortening due to folding and faulting are discussed. Author

N91-23000*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
YOUNG FLOOD LAVAS IN THE ELYSIUM REGION, MARS Abstract Only
J. B. Plescia *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 243-245 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

The nature and origin of a smooth plains unit (the Cerberus Plains) in southeastern Elysium and western Amazonis are reported. The interpretation that the Cerberus Plains resulted from flood plains style volcanism late in martian history is presented which carries implications for martian thermal history and volcanic evolution of a global scale. Although central construct volcanism (e.g., Olympus Mons) has long been recognized as occurring late in time, flood volcanism has not. Flood volcanism has been suggested as the origin of the ridged plains units (e.g., Lunae Planum, Solis, and Sinai Planum). This type of volcanic activity generally occurred early, and in Tharsis, the style of volcanism evolved from flood eruptions into centralized eruptions which built the large Tharsis Montes and Olympus Mons shields. Volcanism in the Elysium region seems to have followed a similar trend from flood eruptions to central construct building. But, the Cerberus Plains indicate that the volcanic style returned to flood eruption again after central constructional volcanism had ended. Author

N91-23001*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
CHEMICAL EVOLUTION OF THE EARLY MARTIAN HYDROSPHERE
M. W. Schaefer (Maryland Univ., College Park.) *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 255-256 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

The chemical evolution of the early Martian hydrosphere is discussed. The early Martian ocean can be modeled as a body of relatively pure water in equilibrium with a dense carbon dioxide atmosphere. The chemical weathering of lavas, pyroclastic deposits, and impact melt sheets would have the effect of neutralizing the acidity of the juvenile water. As calcium and other cations are added to the water by chemical weathering, they are quickly removed by the precipitation of calcium carbonate and other minerals, forming a deposit of limestone beneath the surface of the ocean. As the atmospheric carbon dioxide pressure and the temperature decrease, the Martian ocean would be completely frozen. Given the scenario for the chemical evolution of the northern lowland plains of Mars, it should be possible to draw a few conclusions about the expected mineralogy and geomorphology of this regions. Author

N91-23002*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
COMPLEX EARLY RIFTING IN VALLES MARINERIS: RESULTS FROM PRELIMINARY GEOLOGIC MAPPING OF THE OPHIR PLANUM REGION OF MARS Abstract Only
Richard A. Schultz *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 259 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

Photogeologic mapping of the Ophir Planum quadrangle was undertaken to solve two main problems: (1) what controlled the location, orientation, and growth of Ophir Planum grabens; and (2) how are the grabens and trough faulting related. The rich geological history of the Ophir Planum quadrangle underscores the fundamental importance of faulting in the early growth of Valles Marineris. Author

N91-23003*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
POSSIBLE DEFICIENCY OF LARGE MARTIAN CRATERS AND RELATIVE CRATERING OF THE TERRESTRIAL PLANETS Abstract Only
Richard A. Schultz *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 261-262 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

Mars appears to be deficient in large craters relative to Mercury and the Moon. This relative deficiency conflicts with the interpretation of a common population of impactors within the early inner solar system and suggest either of two possibilities. If the apparent deficiency of martian craters is real then the population of impactors at Mars differed significantly from that closer to the Sun. If the apparent deficiency is not real then the complete crater inventory of Mars should be similar to those of Mercury and the Moon, supporting the interpretation of a single population of impactors. These alternate possibilities can be tested by comparing revised inventories that include partly buried or eroded craters to an estimate of Mars' possible relative crater deficiency. Author

N91-23004*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
STRIKE-SLIP FAULTING, WRINKLE RIDGES, AND TIME VARIABLE STRESS STATES IN THE COPRATES REGION OF MARS Abstract Only
Richard A. Schultz *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 263 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

The existence of strike-slip faults was recently documented in two locations on Mars. Two clear examples are reviewed located southeast of Valles Marineris and preliminary evidence is presented for more widespread strike-slip deformation elsewhere in Coprates. The first two examples show that strike-slip faulting occurred in a broad zone east of the Coprates Rise spanning approximately 400 km east-west by perhaps 1000 km north-south. The last example suggests that the growth of major wrinkle ridges throughout Coprates may have been influenced by horizontally directed shear stresses and that more than one generation of ridges was produced. Thus, 'compressional' deformation of ridged plains south of Valles Marineris was spatially heterogeneous and a temporal change in stress may have been involved. Author

N91-23005*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
GEOLOGY, STRUCTURE, AND STATISTICS OF MULTI-RING BASINS ON MARS Abstract Only
Richard A. Schultz and Herbert V. Frey *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evoluation of Volcanism, Tectonics, and Volatiles 1990 p 265 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

Available data on Martian multi-ring basins were compiled and evaluated using the new 1:15 million scale geologic maps of Mars and global topography was revised as base maps. Published center coordinates and ring diameters of Martian basins were plotted by computer and superimposed onto the base maps. In many cases basin centers or ring diameters or both had to be adjusted to achieve a better fit to the revised maps. It was also found that additional basins can explain subcircular topographic lows as well as map patterns of old Noachian materials, volcanic plains units, and channels in the Tharsis region. Author

N91-23006*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A RADAR-ECHO MODEL FOR MARS Abstract Only
T. W. Thompson and H. J. Moore (Geological Survey, Menlo Park, CA.) *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, amd Volatiles 1990 p 283-284 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

Researchers developed a radar-echo model for Mars based on 12.6 cm continuous wave radio transmissions backscattered from the planet. The model broadly matches the variations in depolarized and polarized total radar cross sections with longitude observed by Goldstone in 1986 along 7 degrees S. and yields echo spectra that are generally similiar to the observed spectra. Radar map units in the model include an extensive cratered uplands unit with weak depolarized echo cross sections, average thermal inertias, moderate normal refelectivities, and moderate rms slopes; the volcanic units of Tharsis, Elysium, and Amazonis regions with strong depolarized echo cross sections, low thermal inertia, low normal reflectivities, and large rms slopes; and the northern planes units with moderate to strong depolarized echo cross sections, moderate to very high thermal inertias, moderate to large normal reflectivities, and moderate rms slopes. The relevance of the model to the interpretation of radar echoes from Mars is discussed.
Author

N91-23007*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PRE-TERRESTRIAL ORIGIN OF RUST IN THE NAKHLA METEORITE Abstract Only
Susan J. Wentworth (Lockheed Engineering and Sciences Co., Houston, TX.) and James L. Gooding *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 298-299 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

The authors present quantative elemental compositions and summarize textural evidence for the pre-terrestrial origin of rust on the Nakhla meteorite. The material in question is called 'rust' because its phase composition remains unknown. Compelling evidence for the pre-terrestrial origin of the rust is found in rust veins truncated by fusion crust and preserved as faults in sutured igneous crystals. Rust veins that approach the meteorite's fusion crust become discontinuous and exhibit vugs that suggest partial decrepitation; no veins that penetrate the fusion crust have been found. Because the rust probably contains volatile compounds, it is reasonable to expect that heating near the ablation surface (formed during atmospheric entry to Earth) would encourage devolatilization of the rust. Hence, the absence of rust veins in fusion crust and vugs in rust veins near fusion crust clearly imply that the rust existed in the meteorite before atmospheric entry.
Author

N91-23008*# Lunar and Planetary Inst., Houston, TX.
POSSIBLE AEOLIAN MEGARIPPLES ON MARS Abstract Only
S. H. Williams *In its* Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 304-305 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

Viking orbiter image frames 442B01-10, at 8 m/pxl resolution show that valley floors are not smooth at all, but rather are covered with mounds of material interpreted as dunes. Striations oriented perpendicular to the valley axis can be seen in several locations. The striations are here interpreted to be aeolian megaripples formed from debris weathered from the yardangs. Terrestrial aeolian megaripples have wavelengths up to 25 m; it is not unreasonable that larger megaripples might form under favorable Martian conditions, given the wind speeds available and the lower Martian gravity. If the megaripple interpretation is correct, then by terrestrial analog the deposit in which they occur has a bimodal particle size distribution. One size will undergo saltation; the other, concentrated at the crests of the megaripples, is too large/and or too dense to be put into saltation. For Mars the former is sand-sized, the latter gravel-sized, provided the materials have typical densities. Author

N91-23009*# Lunar and Planetary Inst., Houston, TX.
PRELIMINARY GEOLOGIC MAPPING NEAR THE NILOSYRTIS MENSAE, MARS Abstract Only
Steven H. Williams and James R. Zimbelman (National Air and Space Museum, Washington, DC.) *In its* Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 306-307 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

Virtually the entire map area is mantled by an irregular deposit of material that is apparently fine-grained and erodible. It is also extremely young, as there is not a single crater larger than 1 km in the map area that was emplaced atop the mantle. Knobs abound in the study area; many are presumably caused by the mantling of pre-existing topography. In many cases the older knob of the core is exposed. Many such knob cores are surrounded by small scarplets; it is not yet clear whether the scarplets are the eroded edges of mantle beds that at one time draped over the knob core and have been subsequently exposed by erosion, or whether they are eroded versions of lobate debris aprons. Many craters in the study area contain concentric crater fill, which may indicate downslope movement of volatile-rich materials or repeated cycles of aeolian gradation. Author

N91-23010*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
CONSTRAINTS ON THE DEPTH AND GEOMETRY OF THE MAGMA CHAMBER OF THE OLYMPUS MONS VOLCANO, MARS Abstract Only
Maria T. Zuber and Peter J. Mouginis-Mark (Hawaii Univ., Honolulu.) *In* Lunar and Planetary Inst., Scientific Results of the NASA-Sponsored Study Project on Mars: Evolution of Volcanism, Tectonics, and Volatiles 1990 p 321-322 (For primary document see N91-22984 14-91)
Avail: NTIS HC/MF A14 CSCL 03B

The summit caldera of the Olympus Mons volcano exhibits one of the clearest examples of tectonic processes associated with shield volcanism on Mars. The radial distance from the center of the transition from concentric ridges to concentric graben within the oldest crater provides a constraint on the geometry and depth of the subsurface magmatic reservoir at the time of subsidence. Here, researchers use this constraint to investigate the size, shape, and depth of the reservoir. Their approach consists of calculating radial surface stresses corresponding to the range of subsurface pressure distributions representing an evacuating magma chamber. They then compare stress patterns to the observed radial positions of concentric ridges and graben. The problem is solved by employing the finite element approach using the program TECTON. Author

N91-23011*# California Univ., Los Angeles. Dept. of Earth and Space Sciences.
ORIGIN AND THERMAL EVOLUTION OF MARS
Gerald Schubert, S. C. Soloman, D. L. Turcotte, M. J. Drake, and N. H. Sleep (Stanford Univ., CA.) 5 Feb. 1990 85 p Revised
(Grants NAG9-39; NAG5-814; NsG-7315; NsG-7297)
(NASA-CR-188095; NAS 1.26:188095) Avail: NTIS HC/MF A05 CSCL 03B

The thermal evolution of Mars is governed by subsolidus mantle convection beneath a thick lithosphere. Models of the interior evolution are developed by parameterizing mantle convective heat transport in terms of mantle viscosity, the superadiabatic temperature rise across the mantle, and mantle heat production. Geological, geophysical, and geochemical observations of the compositon and structure of the interior and of the timing of major events in Martian evolution are used to constrain the model computations. Such evolutionary events include global differentiation, atmospheric outgassing, and the formation of the hemispherical dichotomy and Tharsis. Numerical calculations of fully three-dimensional, spherical convection in a shell the size of the Martian mantle are performed to explore plausible patterns of Martian mantel convection and to relate convective features, such as plumes, to surface features, such as Tharsis. The results from the model calculations are presented. Author

N91-23012*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
JSC DIRECTOR'S DISCRETIONARY FUND PROGRAM Annual Report, 1990
Apr. 1991 99 p
(NASA-TM-102177; NAS 1.15:102177) Avail: NTIS HC/MF A05 CSCL 03B

The Johnson Space Center Director's Discretionary Fund Program Annual Report provides a brief review of the status of projects undertaken during the 1990 fiscal year. Three space exploration initiative related issues were focused on: regenerative life support, human spacecraft design, and lunar surface habitat. A viable program of life sciences, space sciences, and engineering research has been maintained. Author

N91-23013*# Colorado Univ., Boulder. Lab. for Atmospheric and Space Physics.
PLANETARY ATMOSPHERES: MICROWAVE SPECTROSCOPIC AND SPACE PHYSICS Final Report, 1987 - 1990
R. Todd Clancy 1990 53 p
(Grant NAGw-1228)
(NASA-CR-188168; NAS 1.26:188168) Avail: NTIS HC/MF A04 CSCL 03B

Ground-based spectroscopic observations of isotopes of CO in the atmosphere of Mars, Venus, and Titan were collected over the 1982-1990 period. These observations were analyzed to obtain information on the photochemistry, dynamics, and thermal profiles of these planetary atmospheres. In the cases of the mesosphere (80-100 km altitude) of Venus and the lower atmosphere (0-70 km altitude) of Mars, the primary conclusion of this research is that significant interannual variation in the global, thermal, and compositional structures of these atmospheres occur over 10 year periods. The Titan studies have focussed on pinning down the true atmosphere CO abundance. A more detailed summary of the results for each of these planetary atmospheres is provided. Author

N91-23014*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
LIGHTING CONSTRAINTS ON LUNAR SURFACE OPERATIONS
Dean B. Eppler Washington May 1991 28 p
(NASA-TM-4271; S-632; NAS 1.15:4271) Avail: NTIS HC/MF A03 CSCL 03B

An investigation into the levels of ambient lighting on the lunar surface indicates that for most nearside locations, illumination will be adequate throughout most of the lunar night to conduct EVAs with only minor artificial illumination. The maximum lighting available during the lunar night from Earthshine will be similar to the light level on a July evening at approximately 8:00 pm in the southern United States (approximately 15 minutes after sunset). Because of the captured rotation of the Moon about the Earth, the location of the Earth will remain approximately constant throughout the lunar night, with consequent constant shadow length and angle. Variations in the level of Earthside illumination will be solely a function of Earth phase angle. Experience during the Apollo Program suggests that EVA activities during the period around the lunar noon may be difficult due to lack of surface definition caused by elimination of shadows. Author

N91-22976*# Academy of Sciences (USSR), Moscow. Inst. of Geochemistry and Analytical Chemistry.
LITHOSPHERIC AND ATMOSPHERIC INTERACTION ON THE PLANET VENUS
Vladislav P. Volkov *In* NAS-NRC, Planetary Sciences: American and Soviet Research 1991 p 218-233 (For primary document see N91-22960 14-90)
Avail: NTIS HC/MF A14 CSCL 03B

92 SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots.

For related information see *93 Space Radiation.*

N91-23015# Air Force Environmental Technical Applications Center, Scott AFB, IL.
EFFECTIVE SUNSPOT NUMBER (SSNI) COMPARISON STUDY
Mary L. Hart Dec. 1990 36 p
(AD-A231651; USAFETAC/PR-90/005) Avail: NTIS HC/MF A03 CSCL 03/1

This report documents the results of a USAFETAC study done to determine whether or not reliable global effective sunspot numbers for the Air Force Global Weather Central's (AFGWC's) Ionospheric Conductivity and Electron density (ICED) Model could be calculated based on the present number (11) of digital ionosonde sites. The study found that increasing the number of sites would have a limited effect on ICED output, and that it was feasible to run the ICED model using the present 11-station network, subject to certain limitations. GRA

N91-23016# Arizona Univ., Tucson. Dept. of Physics.
SOLAR VARIABILITY OBSERVED THROUGH CHANGES IN SOLAR FIGURE AND MEAN DIAMETER
H. A. Hill 25 Jan. 1991 11 p
(Contract DE-FG02-87ER-13670)
(DE91-009813; DOE/ER-13670/2) Avail: NTIS HC/MF A03

The work performed on solar variability during 1990 at SCLERA is reviewed. That portion of the SCLERA research program supported by the Department of Energy has been directed toward the detection and monitoring of climatically significant solar variability by accurate measurement of the variability in solar shape and diameter. Observations were obtained in 1990 and results from analysis of earlier observations obtained. The observational evidence of systematic long-term changes in the apparent solar diameter and/or radius has been detected, and these changes continue to strongly correlated with long-term changes in solar total irradiance. Additional evidence for internal gravity modes has been found which may be important to understanding the internal structure of the Sun. Each of these findings shows promise for anticipating future changes in the solar luminosity. Progress has been made in setting up an international network based on SCLERA-type instruments to improve the coverage and quality of the observations. A proposal is made for the continuation of support from the Department of Energy for further studies relevant to solar-variability forecasting. DOE

93 SPACE RADIATION

Includes cosmic radiation; and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine.* For theory see *73 Nuclear and High-Energy Physics.*

N91-23017*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
IMPROVEMENTS IN COMPUTATIONAL ACCURACY OF BRYNTRN (A BARYON TRANSPORT CODE)
Judy L. Shinn, John W. Wilson, Mark Weyland, and Francis A. Cucinotta (Rockwell International Corp., Houston, TX.) Washington May 1991 37 p
(NASA-TP-3093; L-16898; NAS 1.60:3093) Avail: NTIS HC/MF A03 CSCL 03B

Extension of BRYNTRN for use in space radiation dose analyses for very large shield thickness is made possible by improving the numerical algorithms. The efforts were concentrated in obtaining more accurate yet efficient interpolation and integration methods at each local computational step and in optimizing the grid distributions. A brief discussion of the nucleon transport theory and propagating formula is also given in conjunction with the analysis of error propagation which reveals the need for minimizing the local truncation errors. Sample calculations were made to verify the new algorithms. An accuracy of approximately 5 percent for a shield thickness of 150 g/sq cm was found when a minimal, thirty-point energy grid was used. This is far superior to the results obtained by using the old algorithms where the solutions can be of an order of magnitude different when a reasonable large number of grid points was used. The propagation step size which is restricted by the perturbation theory was re-evaluated to be in line with the improved numerical accuracy. Author

N91-23018*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
TRITON'S GLOBAL HEAT BUDGET
R. H. Brown, T. V. Johnson, J. D. Goguen, Gerald Schubert, and Martin N. Ross (Aerospace Corp., Los Angeles, CA.) 1991 16 p
(NASA-CR-188178; NAS 1.26:188178) Avail: NTIS HC/MF A03 CSCL 03B

Internal heat flow from radioactive decay in Triton's interior along with absorbed thermal energy from Neptune total 5 to 20 percent of the insolation absorbed by Triton, thus comprising a significant fraction of Triton's surface energy balance. These additional energy inputs can raise Triton's surface temperature between approx. 0.5 to 1.5 K above that possible with absorbed sunlight alone, resulting in a factor of approx. 1.5 to 2.5 increase in Triton's basal atmospheric pressure. If Triton's internal heatflow is concentrated in some areas, as is likely, local effects such as enhanced sublimation with subsequent modification of albedo could be quite large. Furthermore, indications of recent albedo change on Triton suggest that Triton's surface temperature and pressure may not now be in steady state, further suggesting that atmospheric pressure on Triton was as much as 10 times higher in the recent past. Author

N91-23019# Fermi National Accelerator Lab., Batavia, IL.
ULTRAHIGH-ENERGY PARTICLES FROM COSMIC STRINGS
P. Bhattacharjee (Chicago Univ., IL.) Feb. 1991 23 p Presented at the Institute for Cosmic Ray Research (ICRR) International Symposium on Astrophysical Aspects of the Most Energetic Cosmic Rays, Kofu, Japan, 26-29 Nov. 1990
(Contract DE-AC02-76CH-03000)
(DE91-009670; FNAL/C-91/56-A; CONF-9011188-1) Avail: NTIS HC/MF A03

The idea of production of ultrahigh-energy particles in the present universe due to annihilation or collapse of topological defects is discussed. Topological defects, formed in symmetry-breaking phase transitions in the early universe, can survive til today owing to their topological stability. However, under certain circumstances, topological defects may be physically destroyed. When topological defects are destroyed, the energy contained in the defects can be released in the form of massive gauge- and Higgs-bosons of the underlying spontaneously broken gauge theory. Subsequent decay of these massive particles can give rise to energetic particles ranging up to an energy on the order of the mass of the original particles released from the defects. This may give us a 'natural' mechanism of production of extremely energetic cosmic ray particles in the universe today, without the need for any acceleration mechanism. To illustrate this idea, I describe in detail the calculation of the expected ultrahigh-energy proton spectrum due to a specific process which involves collapse or multiple self-intersections of a class of closed cosmic string loops formed in a phase transition at a grand unification energy scale. I discuss the possibility that some of the highest-energy cosmic ray particles are of this origin. By comparing with the observational results on the ultrahigh-energy cosmic rays, we derive an upper limit to the average fraction of the total energy in all 'primary' cosmic string loops that may be released in the form of particles due to collapse or multiple self-intersections of these loops. No nuclei such as alpha's or Fe's are in the spectrum. DOE

99 GENERAL

N91-23020# Wichita State Univ., KS. Inst. for Aviation Research.
[BUSINESS PLANS FOR THE INSTITUTE FOR AVIATION RESEARCH, FY 1990 - FY 1995] Annual Report, FY 1989
Sep. 1989 113 p Sponsored by Kansas Technology Enterprise Corp.
(IAR-89-15) Avail: NTIS HC/MF A06

The design, development, and production of commercial and military aircraft is a significant industry. The Institute for Aviation Research was established to transfer technology and conduct research, educational, and service programs directed toward meeting the challenges of the American aviation industry. Key accomplishments are highlighted. The Center for Basic and Applied Research (the Aerodynamic, Propulsion, Flight Simulation, Structures, and Advanced Materials Laboratory); the Center for Aviation Safety Research; and the Center for Productivity Enhancement (CAS/CAM Laboratory, Composites Laboratory) objectives, goals, and accomplishments are described. B.G.

N91-23021*# National Aeronautics and Space Administration, Washington, DC.
TECHNOLOGY 2000, VOLUME 1
Mar. 1991 416 p Conference held in Washington, DC, 27-28 Nov. 1990
(NASA-CP-3109-Vol-1; NAS 1.55:3109-Vol-1) Avail: NTIS HC/MF A18 CSCL 05A

The purpose of the conference was to increase awareness of existing NASA developed technologies that are available for immediate use in the development of new products and processes, and to lay the groundwork for the effective utilization of emerging technologies. There were sessions on the following: Computer technology and software engineering; Human factors engineering and life sciences; Information and data management; Material sciences; Manufacturing and fabrication technology; Power, energy, and control systems; Robotics; Sensors and measurement technology; Artificial intelligence; Environmental technology; Optics and communications; and Superconductivity. For individual titles, see N91-23022 through N91-23071.

N91-23022*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE VIRTUAL ENVIRONMENT DISPLAY SYSTEM **c61**
Michael W. McGreevy *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 3-9
(For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09B

Virtual environment technology is a display and control technology that can surround a person in an interactive computer generated or computer mediated virtual environment. It has evolved at NASA-Ames since 1984 to serve NASA's missions and goals. The exciting potential of this technology, sometimes called Virtual Reality, Artificial Reality, or Cyberspace, has been recognized recently by the popular media, industry, academia, and government organizations. Much research and development will be necessary to bring it to fruition. Author

N91-23023*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
VIRTUAL ACOUSTICS DISPLAYS c71
Elizabeth M. Wenzel, Scott S. Fisher, Philip K. Stone, and Scott H. Foster (Crystal River Engineering, Groveland, Ca.) *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 10-20 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 20A

The real time acoustic display capabilities are described which were developed for the Virtual Environment Workstation (VIEW) Project at NASA-Ames. The acoustic display is capable of generating localized acoustic cues in real time over headphones. An auditory symbology, a related collection of representational auditory 'objects' or 'icons', can be designed using ACE (Auditory Cue Editor), which links both discrete and continuously varying acoustic parameters with information or events in the display. During a given display scenario, the symbology can be dynamically coordinated in real time with 3-D visual objects, speech, and gestural displays. The types of displays feasible with the system range from simple warnings and alarms to the acoustic representation of multidimensional data or events. Author

N91-23024*# Sterling Federal Systems, Inc., Palo Alto, CA.
FAST: A MULTI-PROCESSED ENVIRONMENT FOR VISUALIZATION OF COMPUTATIONAL FLUID c34
Gordon V. Bancroft, Fergus J. Merritt, Todd C. Plessel, Paul G. Kelaita, R. Kevin McCabe, and Al Globus *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 21-30 (For primary document see N91-23021 14-99) (Contract NAS2-11555)
Avail: NTIS HC/MF A18 CSCL 20D

Three dimensional, unsteady, multizoned fluid dynamics simulations over full scale aircraft is typical of problems being computed at NASA-Ames on CRAY2 and CRAY-YMP supercomputers. With multiple processor workstations available in the 10 to 30 Mflop range, it is felt that these new developments in scientific computing warrant a new approach to the design and implementation of analysis tools. These large, more complex problems create a need for new visualization techniques not possible with the existing software or systems available as of this time. These visualization techniques will change as the supercomputing environment, and hence the scientific methods used, evolve ever further. Visualization of computational aerodynamics require flexible, extensible, and adaptable software tools for performing analysis tasks. FAST (Flow Analysis Software Toolkit), an implementation of a software system for fluid mechanics analysis that is based on this approach is discussed. Author

N91-23025*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
HYPERCUBE TECHNOLOGY c60
Jay W. Parker, Tom Cwik, Robert D. Ferraro, Paulett C. Liewer, and Jean E. Patterson *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 31-41 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09B

The JPL designed MARKIII hypercube supercomputer has been in application service since June 1988 and has had successful application to a broad problem set including electromagnetic scattering, discrete event simulation, plasma transport, matrix algorithms, neural network simulation, image processing, and graphics. Currently, problems that are not homogeneous are being attempted, and, through this involvement with real world applications, the software is evolving to handle the heterogeneous class problems efficiently. Author

N91-23026*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Center for Space Microelectronics Technology.
HYPERSWITCH COMMUNICATION NETWORK c62
J. Peterson, M. Pniel, and E. Upchurch *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 42-52 Sponsored by Strategic Defense Initiative Organization, Washington DC and ESD, Hanscom AFB, MA (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09B

The Hyperswitch Communication Network (HCN) is a large,scale parallel computer prototype being developed at JPL. Commercial versions of the HCN computer are planned. The HCN computer being designed is a message passing multiple instruction multiple data (MIMD) computer, and offers many advantages in price-performance ratio, reliability and availability, and manufacturing over traditional uniprocessors and bus based multiprocessors. The design of the HCN operating system is a uniquely flexible environment that combines both parallel processing and distributed processing. This programming paradigm can achieve a balance among the following competing factors: performance in processing and communications, user friendliness, and fault tolerance. The prototype is being designed to accommodate a maximum of 64 state of the art microprocessors. The HCN is classified as a distributed supercomputer. The HCN system is described, and the performance/cost analysis and other competing factors within the system design are reviewed. Author

N91-23027*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
BIOLOGICAL NEURAL NETWORKS AS MODEL SYSTEMS FOR DESIGNING FUTURE PARALLEL PROCESSING COMPUTERS c63
Muriel D. Ross *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 53-61 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09B

One of the more interesting debates of the present day centers on whether human intelligence can be simulated by computer. The author works under the premise that neurons individually are not smart at all. Rather, they are physical units which are impinged upon continuously by other matter that influences the direction of voltage shifts across the units membranes. It is only the action of a great many neurons, billions in the case of the human nervous system, that intelligent behavior emerges. What is required to understand even the simplest neural system is painstaking analysis, bit by bit, of the architecture and the physiological functioning of its various parts. The biological neural network studied, the vestibular utricular and saccular maculas of the inner ear, are among the most simple of the mammalian neural networks to understand and model. While there is still a long way to go to understand even this most simple neural network in sufficient detail for extrapolation to computers and robots, a start was made. Moreover, the insights obtained and the technologies developed help advance the understanding of the more complex neural networks that underlie human intelligence. Author

N91-23028*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
BIOMEDICAL APPLICATIONS OF NASA TECHNOLOGY c51
Donald S. Friedman *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 63-65 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 06C

Through the active transfer of technology, NASA Technology Utilization (TU) Program assists private companies, associations, and government agencies to make effective use of NASA's technological resources to improve U.S. economic competitiveness and to provide societal benefit. Aerospace technology from such areas as digital image processing, space medicine and biology,

microelectronics, optics, and electro-optics, and ultrasonic imaging have found many secondary applications in medicine. Examples of technology spinoffs are briefly discussed to illustrate the benefits realized through adaptation of aerospace technology to solve health care problems. Successful implementation of new technologies increasingly requires the collaboration of industry, universities, and government and the TU Program serves as the liaison to establish such collaborations with NASA. NASA technology is an important resource to support the development of new medical products and techniques that will further advance the quality of health care available in the U.S. and worldwide. Author

N91-23029*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
DIRECTION DISCRIMINATING HEARING AID SYSTEM c54
M. Jhabvala, H. C. Lin, and G. Ward (Design Three, Inc., Oxon Hill, MD.) *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 66-72 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 05H

A visual display was developed for people with substantial hearing loss in either one or both ears. The system consists of three discreet units; an eyeglass assembly for the visual display of the origin or direction of sounds; a stationary general purpose noise alarm; and a noise seeker wand. Author

N91-23030*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
X RAY IMAGING MICROSCOPE FOR CANCER RESEARCH c52
Richard B. Hoover, David L. Shealy, B. R. Brinkley, Phillip C. Baker, Troy W. Barbee, Jr., and Arthur B. C. Walker, Jr. (Stanford Univ., CA.) *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 73-82 (For primary document see N91-23021 14-99)
(Contract NsG-5131; W-7405-eng-48)
Avail: NTIS HC/MF A18 CSCL 14B

The NASA technology employed during the Stanford MSFC LLNL Rocket X Ray Spectroheliograph flight established that doubly reflecting, normal incidence multilayer optics can be designed, fabricated, and used for high resolution x ray imaging of the Sun. Technology developed as part of the MSFC X Ray Microscope program, showed that high quality, high resolution multilayer x ray imaging microscopes are feasible. Using technology developed at Stanford University and at the DOE Lawrence Livermore National Laboratory (LLNL), Troy W. Barbee, Jr. has fabricated multilayer coatings with near theoretical reflectivities and perfect bandpass matching for a new rocket borne solar observatory, the Multi-Spectral Solar Telescope Array (MSSTA). Advanced Flow Polishing has provided multilayer mirror substrates with sub-angstrom (rms) smoothnesss for the astronomical x ray telescopes and x ray microscopes. The combination of these important technological advancements has paved the way for the development of a Water Window Imaging X Ray Microscope for cancer research. Author

N91-23031*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MECHANICAL RESPONSE TISSUE ANALYZER FOR ESTIMATING BONE STRENGTH c52
Sara B. Arnaud, Charles Steele, and Anthony Mauriello (GaitScan, Inc., Ridgewood, NJ.) *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 83-88 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 14B

One of the major concerns for extended space flight is weakness of the long bones of the legs, composed primarily of cortical bone, that functions to provide mechanical support. The strength of cortical bone is due to its complex structure, described simplistically as cylinders of parallel osteons composed of layers of mineralized collagen. The reduced mechanical stresses during space flight or immobilization of bone on Earth reduces the mineral content, and changes the components of its matrix and structure so that its strength is reduced. Currently, the established clinical measures of bone strength are indirect. The measures are based on determinations of mineral density by means of radiography, photon absorptiometry, and quantitative computer tomography. While the mineral content of bone is essential to its strength, there is growing awareness of the limitations of the measurement as the sole predictor of fracture risk in metabolic bone diseases, especially limitations of the measurement as the sole predictor of fracture risk in metabolic bone diseases, especially osteoporosis. Other experimental methods in clinical trials that more directly evaluate the physical properties of bone, and do not require exposure to radiation, include ultrasound, acoustic emission, and low-frequency mechanical vibration. The last method can be considered a direct measure of the functional capacity of a long bone since it quantifies the mechanical response to a stimulus delivered directly to the bone. A low frequency vibration induces a response (impedance) curve with a minimum at the resonant frequency, that a few investigators use for the evaluation of the bone. An alternative approach, the method under consideration, is to use the response curve as the basis for determination of the bone bending stiffness EI (E is the intrinsic material property and I is the cross-sectional moment of inertia) and mass, fundamental mechanical properties of bone. Author

N91-23032*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ADAPTATION OF NASA TECHNOLOGY FOR THE OPTIMIZATION OF ORTHOPEDIC KNEE IMPLANTS c52
D. A. Saravanos, P. J. Mraz (Case Western Reserve Univ., Cleveland, OH.), and D. A. Hopkins *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 89-98 (For primary document see N91-23021 14-99)
(Grant NAG3-1027)
Avail: NTIS HC/MF A18 CSCL 05H

The NASA technology originally developed for the optimization of composite structures (engine blades) is adapted and applied to the optimization of orthopedic knee implants. A method is developed enabling the tailoring of the implant for optimal interaction with the environment of the tibia. The shape of the implant components are optimized, such that the stresses in the bone are favorably controlled to minimize bone degradation and prevent failures. A pilot tailoring system is developed and the feasibility of the concept is elevated. The optimization system is expected to provide the means for improving knee prosthesis and individual implant tailoring for each patient. Author

N91-23033*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
OPTICAL STORAGE DEVICE c60
Sharon S. Welch *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 101-108 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09B

A new holographic image storage device which uses four-wave mixing in two photorefractive crystals is described. Photorefractive crystals promise information storage densities on the order of 10(exp 9) to 10(exp 12) bits per cubic centimeter at real-time rates. Several studies in recent years have investigated the use of photorefractive crystals for storing holographic image information. However, all of the previous studies have focused on techniques for storing information in a single crystal. The disadvantage of using a single crystal is that the read process is destructive. Researchers have developed techniques for fixing the information in a crystal so that it may be read many times. However, when fixed, the information cannot be readily erased and overwritten with new information. It two photorefractive crystals are used, holographic image information may be stored dynamically. That is, the stored image information may be read out more than once, and it may be easily erased and overwritten with new image information. Author

N91-23034*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
REWRITEABLE OPTICAL DISK RECORDER DEVELOPMENT **c60**
Thomas A. Shull and Pamela L. Rinsland *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 109-118 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09B

A NASA program to develop a high performance (high rate, high capability) rewriteable optical disk recorder for spaceflight applications is presented. An expandable, adaptable system concept is proposed based on disk Drive modules and a modular Controller. Drive performance goals are 10 gigabyte capacity are up to 1.8 gigabits per second rate with concurrent I/O, synchronous data transfer, and 2 to 5 years operating life in orbit. Technology developments, design concepts, current status, and future plans are presented. Author

N91-23035*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
MONITORING AND ANALYSIS OF DATA FROM COMPLEX SYSTEMS **c82**
Thomas Dollman and Kenneth Webster *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 119-126 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 05B

Some of the methods, systems, and prototypes that have been tested for monitoring and analyzing the data from several spacecraft and vehicles at the Marshall Space Flight Center are introduced. For the Huntsville Operations Support Center (HOSC) infrastructure, the Marshall Integrated Support System (MISS) provides a migration path to the state-of-the-art workstation environment. Its modular design makes it possible to implement the system in stages on multiple platforms without the need for all components to be in place at once. The MISS provides a flexible, user-friendly environment for monitoring and controlling orbital payloads. In addition, new capabilities and technology may be incorporated into MISS with greater ease. The use of information systems technology in advanced prototype phases, as adjuncts to mainline activities, is used to evaluate new computational techniques for monitoring and analysis of complex systems. Much of the software described (specially, HSTORESIS (Hubble Space Telescope Operational Readiness Expert Safemode Investigation System), DRS (Device Reasoning Shell), DART (Design Alternatives Rational Tool), elements of the DRA (Document Retrieval Assistant), and software for the PPS (Peripheral Processing System) and the HSPP (High-Speed Peripheral Processor)) is available with supporting documentation, and may be applicable to other system monitoring and analysis applications. Author

N91-23036*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
HIGH DATA RATE SYSTEMS FOR THE FUTURE **c82**
John Chitwood *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 127-136 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 05B

Information systems in the next century will transfer data at rates that are much greater than those in use today. Satellite based communication systems will play an important role in networking users. Typical data rates; use of microwave, millimeter wave, or optical systems; millimeter wave communication technology; modulators/exciters; solid state power amplifiers; beam waveguide transmission systems; low noise receiver technology; optical communication technology; and the potential commercial applications of these technologies are discussed. B.G.

N91-23037*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
DISTRIBUTED ACCESS VIEW INTEGRATED DATABASE (DAVID) SYSTEM **c82**
Barry E. Jacobs *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 137-143 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 05B

The Distributed Access View Integrated Database (DAVID) System, which was adopted by the Astrophysics Division for their Astrophysics Data System, is a solution to the system heterogeneity problem. The heterogeneous components of the Astrophysics problem is outlined. The Library and Library Consortium levels of the DAVID approach are described. The 'books' and 'kits' level is discussed. The Universal Object Typer Management System level is described. The relation of the DAVID project with the Small Business Innovative Research (SBIR) program is explained. B.G.

N91-23038*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Visualization and Earth Science Applications Group.
THREE-DIMENSIONAL PERSPECTIVE VISUALIZATION **c61**
Kevin Hussey *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 144-146 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09B

It was demonstrated that image processing computer graphic techniques can provide an effective means of physiographic analysis of remotely sensed regions through the use of three-dimensional perspective rendering. THe methods used to simulate and animate three-dimensional surfaces from two-dimensional imagery and digital elevation models are explained. A brief historic look at JPL's efforts in this field and several examples of animations, illustrating the evolution of these techniques from 1985, are shown. JPL's current research in this area is discussed along with examples of technology transfer and potential commercial application. The software is part of the VICAR (Video Image Communication and Retrieval) image processing system which was developed at the Multimission Image Processing Laboratory of JPL. Author

N91-23039*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HIGH PERFORMANCE POLYMER DEVELOPMENT **c27**
Paul M. Hergenrother *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 149-155 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 11C

The term high performance as applied to polymers is generally associated with polymers that operate at high temperatures. High performance is used to describe polymers that perform at temperatures of 177 C or higher. In addition to temperature, other factors obviously influence the performance of polymers such as thermal cycling, stress level, and environmental effects. Some recent developments at NASA Langley in polyimides, poly(arylene ethers), and acetylenic terminated materials are discussed. The high performance/high temperature polymers discussed are representative of the type of work underway at NASA Langley Research Center. Further improvement in these materials as well as the development of new polymers will provide technology to help meet NASA future needs in high performance/high temperature applications. In addition, because of the combination of properties offered by many of these polymers, they should find use in many other applications. B.G.

N91-23040*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INDUSTRIAL APPLICATIONS OF GRAPHITE FLUORIDE FIBERS **c24**
Ching-Cheh Hung and Donald Kucera (Cleveland State Univ., OH.) *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 156-164 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 11D

Based on fluorination technology developed during 1934 to 1959, and the fiber technology developed during the 1970s, a new process was developed to produce graphite fluoride fibers. In the process, pitch based graphitized carbon fibers are at first

intercalated and deintercalated several times by bromine and iodine, followed by several cycles of nitrogen heating and fluorination at 350 to 370 C. Electrical, mechanical, and thermal properties of this fiber depend on the fluorination process and the fluorine content of the graphite fluoride product. However, these properties are between those of graphite and those of PTFE (Teflon). Therefore, it is considered to be a semiplastic. The physical properties suggest that this new material may have many new and unexplored applications. For example, it can be a thermally conductive electrical insulator. Its coefficient of thermal expansion (CTE) can be adjusted to match that of silicon, and therefore, it can be a heat sinking printed circuit board which is CTE compatible with silicon. Using these fibers in printed circuit boards may provide improved electrical performance and reliability of the electronics on the board over existing designs. Also, since it releases fluorine at 300 C or higher, it can be used as a material to store fluorine and to conduct fluorination. This application may simplify the fluorination process and reduce the risk of handling fluorine.

Author

N91-23041*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

UNIQUE APPLICATIONS OF FLUOROEPOXY MATERIALS **c24**

Sheng Yen Lee *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 165-172 (For primary document see N91-23021 14-99)

Avail: NTIS HC/MF A18 CSCL 11D

The following subject areas are covered: (1) fluoroepoxy and curing agents; (2) an excellent moisture vapor barrier coating; (3) as adhesives to bond Teflon without any surface treatment; (4) a new method to make thermosetting fluoropolymer foam; and (5) as a new antifoaming agent for epoxy material manufacturing and processing.

Author

N91-23042*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

DUAL ION BEAM PROCESSED DIAMONDLIKE FILMS FOR INDUSTRIAL APPLICATIONS **c27**

M. J. Mirtich, M. T. Kussmaul (Sverdrup Technology, Inc., Brook Park, OH.), B. A. Banks, and J. S. Sovey *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 173-183 (For primary document see N91-23021 14-99)

Avail: NTIS HC/MF A18 CSCL 11C

Single and dual beam ion source systems are used to generate amorphous diamondlike carbon (DLC) films, which were evaluated for a variety of applications including protective coatings on transmitting materials, power electronics as insulated gates and corrosion resistant barriers. A list of the desirable properties of DLC films along with potential applications are presented.

Author

N91-23043*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

PLASMA-POLYMERIZED COATING FOR POLYCARBONATE: SINGLE-LAYER, ABRASION RESISTANT, AND ANTIREFLECTION **c27**

Theodore Wydeven *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 184-188 (For primary document see N91-23021 14-99)

Avail: NTIS HC/MF A18 CSCL 11C

Plasma-polymerized vinyl trimethoxy silane films were deposited on transparent polycarbonate substrates. The adherent, clear films protected the substrates from abrasion and also served as antireflection coatings. Post-treatment of the vinyl trimethoxy silane films in an oxygen glow discharge further improved their abrasion resistance. The coatings were characterized by elemental analysis of the bulk, ESCA analysis of the surface, transmission, thickness, abrasion resistance, haze, and adhesion. This patented process is currently used by the world's largest manufacturers of non-prescription sunglasses to protect the plastic glasses from scratching and thereby to increase their useful lifetime. Author

N91-23044*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THE PM-200 LUBRICATION SYSTEM **c27**

Harold E. Sliney *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 189-196 (For primary document see N91-23021 14-99)

Avail: NTIS HC/MF A18 CSCL 11C

Plasma sprayed composite coating of metal-bonded chromium carbide with additions of silver and thermochemically stable fluorides were previously reported to be lubricative in pin on desk bench tests from room temperature to 900 C. An early coating formulation of this type, designated as PS-200, was successfully tested as a cylinder coating in a Stirling engine at a TRRT of 760 C in a hydrogen atmosphere, and as a backup lubricant for gas bearings to 650 C. A subsequent optimization program has shown that tribological properties are further improved by increasing the solid lubricant content. The improved coating is designated as PS-212. The same powder formulation was used to make free-standing powder metallurgy (PM-212) parts by sintering or hot isostatic pressing. The process is very attractive for making parts that cannot be readily plasma sprayed such as bushings and cylinders that have small bore diameters and/or high length to diameter ratios. The properties of coatings and free-standing parts fabricated from these powders are reviewed. Author

N91-23045*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

ROBOTICS IN SPACE-AGE MANUFACTURING **c37**

Chip Jones *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 199-207 (For primary document see N91-23021 14-99)

Avail: NTIS HC/MF A18 CSCL 13I

Robotics technologies are developed to improve manufacturing of space hardware. The following applications of robotics are covered: (1) welding for the space shuttle and space station Freedom programs; (2) manipulation of high-pressure water for shuttle solid rocket booster refurbishment; (3) automating the application of insulation materials; (4) precision application of sealants; and (5) automation of inspection procedures. Commercial robots are used for these development programs, but they are teamed with advanced sensors, process controls, and computer simulation to form highly productive manufacturing systems. Many of the technologies are also being actively pursued in private sector manufacturing operations.

Author

N91-23046*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

VARIABLE POLARITY ARC WELDING **c37**

E. O. Bayless, Jr. *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 208-213 (For primary document see N91-23021 14-99)

Avail: NTIS HC/MF A18 CSCL 13H

Technological advances generate within themselves dissatisfactions that lead to further advances in a process. A series of advances in welding technology which culminated in the Variable Polarity Plasma Arc (VPPA) Welding Process and an advance instituted to overcome the latest dissatisfactions with the process: automated VPPA welding are described briefly.

Author

N91-23047*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

HIGH PRESSURE WATER JET CUTTING AND STRIPPING **c37**

David T. Hoppe and Majid K. Babai *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 214-220 (For primary document see N91-23021 14-99)

Avail: NTIS HC/MF A18 CSCL 13H

High pressure water cutting techniques have a wide range of applications to the American space effort. Hydroblasting techniques are commonly used during the refurbishment of the reusable solid rocket motors. The process can be controlled to strip a thermal protective ablator without incurring any damage to the painted

surface underneath by using a variation of possible parameters. Hydroblasting is a technique which is easily automated. Automation removes personnel from the hostile environment of the high pressure water. Computer controlled robots can perform the same task in a fraction of the time that would be required by manual operation. Author

N91-23048*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COST-EFFICIENT MANUFACTURING OF COMPOSITE STRUCTURES **c24**
W. Tom Freeman, John G. Davis, and Norman J. Johnston *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 221-230 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 11D

The Advanced Composites Technology (ACT) program is seeking research breakthroughs that will allow structures made of graphite epoxy materials to replace metals in the wings and fuselages of future aircrafts. NASA's goals are to reduce acquisition cost by 20 to 25 percent, structural weight for a resized aircraft by 40 to 50 percent, and the number of parts by half compared to current production aluminum aircraft. The innovative structural concepts, materials, and fabrication techniques emerging from the ACT program are described, and the relationship between aerospace developments and industrial, commercial, and sporting goods applications are discussed. Author

N91-23049*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RAPID INDUCTION BONDING OF COMPOSITES, PLASTICS, AND METALS **c24**
John D. Buckley and Robert L. Fox *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 231-240 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 11D

The Toroid Bonding Gun is and induction heating device. It is a self contained, portable, low powered induction welding system developed for bonding or joining plastic, ceramic, or metallic parts. Structures can be bonded in a factory or in a the field. This type of equipment allows for applying heat directly to the bond lines and/or to the adhesives without heating the entire structure, supports, and fixtures of a bonding assembly. The induction heating gun originally developed for use in the fabrication of space Gangs of bonders are now used to rapidly join composite sheet and structural components. Other NASA-developed applications of this bonding technique include the joining of thermoplastic composites, thermosetting composites, metals, and combinations of these materials. Author

N91-23050*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
RELIABILITY AND RISK ASSESSMENT OF STRUCTURES **c38**
C. C. Chamis *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 241-248 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 14D

Development of reliability and risk assessment of structural components and structures is a major activity at Lewis Research Center. It consists of five program elements: (1) probabilistic loads; (2) probabilistic finite element analysis; (3) probabilistic material behavior; (4) assessment of reliability and risk; and (5) probabilistic structural performance evaluation. Recent progress includes: (1) the evaluation of the various uncertainties in terms of cumulative distribution functions for various structural response variables based on known or assumed uncertainties in primitive structural variables; (2) evaluation of the failure probability; (3) reliability and risk-cost assessment; and (4) an outline of an emerging approach for eventual certification of man-rated structures by computational methods. Collectively, the results demonstrate that the structural durability/reliability of man-rated structural components and structures can be effectively evaluated by using formal probabilistic methods. Author

N91-23051*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A SEMI-AUTOMATED PROCESS FOR THE PRODUCTION OF CUSTOM-MADE SHOES **c31**
Franklin H. Farmer *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 249-253 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13H

A more efficient, cost-effective and timely way of designing and manufacturing custom footware is needed. A potential solution to this problem lies in the use of computer-aided design and manufacturing (CAD/CAM) techniques in the production of custom shoes. A prototype computer-based system was developed, and the system is primarily a software entity which directs and controls a 3-D scanner, a lathe or milling machine, and a pattern-cutting machine to produce the shoe last and the components to be assembled into a shoe. The steps in this process are: (1) scan the surface of the foot to obtain a 3-D image; (2) thin the foot surface data and create a tiled wire model of the foot; (3) interactively modify the wire model of the foot to produce a model of the shoe last; (4) machine the last; (5) scan the surface of the last and verify that it correctly represents the last model; (6) design cutting patterns for shoe uppers; (7) cut uppers; (8) machine an inverse mold for the shoe innersole/sole combination; (9) mold the innersole/sole; and (10) assemble the shoe. For all its capabilities, this system still requires the direction and assistance of skilled operators, and shoemakers to assemble the shoes. Currently, the system is running on a SUN3/260 workstation with TAAC application accelerator. The software elements of the system are written in either Fortran or C and run under a UNIX operator system. Author

N91-23052*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
LIGHTWEIGHT, FIRE-RETARDANT, CRASHWORTHY AIRCRAFT SEAT CUSHIONING **c03**
Leonard A. Haslim and Paul T. McDonough *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 254-259 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 01C

A two page discussion of non-aerospace seating applications and the design of NASA's safety seat cushioning (SSC) is presented. The SSC was designed for both safety and comfort in order to replace polyurethane cushioning which is flammable and produces lethal fumes upon combustion. The SSC is composed of advanced fabric reinforced composites and is lightweight, fire-retardent, and crashworthy. The seat design consists of central elliptical tubular spring supports made of fire-resistant and fatigue-durable composites surrounded by a fire-blocking sheath. The cushioning is made crashworthy by incorporating energy-absorbing, viscoelastic layers between the nested, elliptical-hoop springs. The design is intended to provide comfortable seating that meets aircraft-loading requirements without using the conventional polyurethane materials. The designs of an aircraft seat and structural components of the SSC are also presented. K.S.

N91-23053*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CIVIL AIR TRANSPORT: A FRESH LOOK AT POWER-BY-WIRE AND FLY-BY-LIGHT **c08**
Gale R. Sundberg *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 263-267 Previously announced as N90-21283 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 01C

Power-by-wire (PBW) is a key element under subsonic transport flight systems technology with potential savings of over 10 percent

in operating empty weight and in fuel consumption compared to today's transport aircraft. The PBW technology substitutes electrical actuation in place of centralized hydraulics, uses internal starter-motor/generators and eliminates the need for variable engine bleed air to supply cabin comfort. The application of advanced fiber optics to the electrical power system controls, to built-in-test (BIT) equipment, and to fly-by-light (FBL) flight controls provides additional benefits in lightning and high energy radio frequency (HERF) immunity over existing mechanical or even fly-by-wire controls. The program plan is reviewed and a snapshot is given of the key technologies and their benefits to all future aircraft, both civil and military. Author

N91-23054*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

SOLAR POWERED STIRLING CYCLE ELECTRICAL GENERATOR **c44**

Richard K. Shaltens *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 269-278 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 10B

Under NASA's Civil Space Technology Initiative (CSTI), the NASA Lewis Research Center is developing the technology needed for free-piston Stirling engines as a candidate power source for space systems in the late 1990's and into the next century. Space power requirements include high efficiency, very long life, high reliability, and low vibration. Furthermore, system weight and operating temperature are important. The free-piston Stirling engine has the potential for a highly reliable engine with long life because it has only a few moving parts, non-contacting gas bearings, and can be hermetically sealed. These attributes of the free-piston Stirling engine also make it a viable candidate for terrestrial applications. In cooperation with the Department of Energy, system designs are currently being completed that feature the free-piston Stirling engine for terrestrial applications. Industry teams were assembled and are currently completing designs for two Advanced Stirling Conversion Systems utilizing technology being developed under the NASA CSTI Program. These systems, when coupled with a parabolic mirror to collect the solar energy, are capable of producing about 25 kW of electricity to a utility grid. Industry has identified a niche market for dish Stirling systems for worldwide remote power application. They believe that these niche markets may play a major role in the introduction of Stirling products into the commercial market. Author

N91-23055*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

FOUR QUADRANT CONTROL OF INDUCTION MOTORS **c33**

Irving G. Hansen *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 279-286 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09A

Induction motors are the nation's workhorse, being the motor of choice in most applications due to their simple rugged construction. It has been estimated that 14 to 27 percent of the country's total electricity use could be saved with adjustable speed drives. Until now, induction motors have not been suited well for variable speed or servo-drives, due to the inherent complexity, size, and inefficiency of their variable speed controls. Work at NASA Lewis Research Center on field oriented control of induction motors using pulse population modulation method holds the promise for the desired drive electronics. The system allows for a variable voltage to frequency ratio which enables the user to operate the motor at maximum efficiency, while having independent control of both the speed and torque of an induction motor in all four quadrants of the speed torque map. Multiple horsepower machine drives were demonstrated, and work is on-going to develop a 20 hp average, 40 hp peak class of machine. The pulse population technique, results to date, and projections for implementation of this existing new motor control technology are discussed. Author

N91-23056*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

HIGH POWER BIPOLAR LEAD-ACID BATTERIES **c33**

Gerald Halpert and Alan Attia *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 287-293 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 10C

The Jet Propulsion Laboratory (JPL), with interest in advanced energy storage systems, is involved in the development of a unique lead acid battery design. This battery utilizes the same combination of lead and lead dioxide active materials present in the automobile starting battery. However, it can provide 2 to 10 times the power while minimizing volume and weight. The typical starting battery is described as a monopolar type using one current collector for both the positive and negative plate of adjacent cells. Specific power as high as 2.5 kW/kg was projected for 30 second periods with as many as 2000 recharge cycles. Author

N91-23057*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

SCIENTIFIC CCD TECHNOLOGY AT JPL **c33**

J. Janesick, S. A. Collins, and E. R. Fossum *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 294-300 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09C

Charge-coupled devices (CCD's) were recognized for their potential as an imaging technology almost immediately following their conception in 1970. Twenty years later, they are firmly established as the technology of choice for visible imaging. While consumer applications of CCD's, especially the emerging home video camera market, dominated manufacturing activity, the scientific market for CCD imagers has become significant. Activity of the Jet Propulsion Laboratory and its industrial partners in the area of CCD imagers for space scientific instruments is described. Requirements for scientific imagers are significantly different from those needed for home video cameras, and are described. An imager for an instrument on the CRAF/Cassini mission is described in detail to highlight achieved levels of performance. Author

N91-23058*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

ADVANCED THERMAL CONTROL TECHNOLOGY FOR COMMERCIAL APPLICATIONS **c34**

Theodore D. Swanson *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 301-306 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 20D

A number of the technologies previously developed for the thermal control of spacecraft have found their way into commercial application. Specialized coatings and heat pipes are but two examples. The thermal control of current and future spacecraft is becoming increasingly more demanding, and a variety of new technologies are being developed to meet these needs. Closed two-phase loops are perceived to be the answer to many of the new requirements. All of these technologies are discussed, and their spacecraft and current terrestrial applications are summarized. Author

N91-23059*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

ROBOSIM, A SIMULATOR FOR ROBOTIC SYSTEMS **c37**

Elaine M. Hinman, Ken Fernandez, and George E. Cook (Vanderbilt Univ., Nashville, TN.) *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 309-314 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13I

ROBOSIM, a simulator for robotic systems, was developed by NASA to aid in the rapid prototyping of automation. ROBOSIM has allowed the development of improved robotic systems concepts for both earth-based and proposed on-orbit applications while significantly reducing development costs. In a cooperative effort with an area university, ROBOSIM was further developed for use

in the classroom as a safe and cost-effective way of allowing students to study robotic systems. Students have used ROBOSIM to study existing robotic systems and systems which they have designed in the classroom. Since an advanced simulator/trainer of this type is beneficial not only to NASA projects and programs but industry and academia as well, NASA is in the process of developing this technology for wider public use. An update on the simulators's new application areas, the improvements made to the simulator's design, and current efforts to ensure the timely transfer of this technology are presented. Author

N91-23060*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
CONTROL SYSTEM SOFTWARE, SIMULATION, AND ROBOTIC APPLICATIONS **c63**
Harold P. Frisch *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 315-321 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 09B

All essential existing capabilities needed to create a man-machine interaction dynamics and performance (MMIDAP) capability are reviewed. The multibody system dynamics software program Order N DISCOS will be used for machine and musculo-skeletal dynamics modeling. The program JACK will be used for estimating and animating whole body human response to given loading situations and motion constraints. The basic elements of performance (BEP) task decomposition methodologies associated with the Human Performance Institute database will be used for performance assessment. Techniques for resolving the statically indeterminant muscular load sharing problem will be used for a detailed understanding of potential musculotendon or ligamentous fatigue, pain, discomfort, and trauma. The envisioned capacity is to be used for mechanical system design, human performance assessment, extrapolation of man/machine interaction test data, biomedical engineering, and soft prototyping within a concurrent engineering (CE) system. Author

N91-23061*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
TELEROBOTIC ELECTRONIC MATERIALS PROCESSING EXPERIMENT **c37**
Stanford Ollendorf *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 322-327 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13H

The Office of Commercial Programs (OCP), working in conjunction with NASA engineers at the Goddard Space Flight Center, is supporting research efforts in robot technology and microelectronics materials processing that will provide many spinoffs for science and industry. The Telerobotic Materials Processing Experiment (TRMPX) is a Shuttle-launched materials processing test payload using a Get Away Special can. The objectives of the project are to define, develop, and demonstrate an automated materials processing capability under realistic flight conditions. TRMPX will provide the capability to test the production processes that are dependent on microgravity. The processes proposed for testing include the annealing of amorphous silicon to increase grain size for more efficient solar cells, thin film deposition to demonstrate the potential of fabricating solar cells in orbit, and the annealing of radiation damaged solar cells. Author

N91-23062*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
ADVANCED MECHANISMS FOR ROBOTICS **c37**
John M. Vranish *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 328-335 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13I

An overview of applied research and development at the Goddard Space Flight Center (GSFC) on mechanisms and collision avoidance skin for robots is presented. The work on robot end effectors is outlined, followed by a brief discussion of robot-friendly payload latching mechanisms and compliant joints. This is followed by discussions of the collision avoidance/management skin and the GSFC research on magnetorestrictive direct drive motors. A new project, the artificial muscle, is introduced. Each of the devices is described sufficiently to permit a basic understanding of its purpose, capabilities, and operating fundamentals. The implications for commercialization are discussed. Author

N91-23063*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE FLIGHT TELEROBOTIC SERVICER AND TECHNOLOGY TRANSFER **c37**
James F. Andary and Kayland Z. Bradford (Martin Marietta Corp., Denver, CO.) *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 336-343 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13I

The Flight Telerobotic Servicer (FTS) project at the Goddard Space Flight Center is developing an advanced telerobotic system to assist in and reduce crew extravehicular activity (EVA) for Space Station Freedom (SSF). The FTS will provide a telerobotic capability in the early phases of the SSF program and will be employed for assembly, maintenance, and inspection applications. The current state of space technology and the general nature of the FTS tasks dictate that the FTS be designed with sophisticated teleoperational capabilities for its internal primary operating mode. However, technologies such as advanced computer vision and autonomous planning techniques would greatly enhance the FTS capabilities to perform autonomously in less structured work environments. Another objective of the FTS program is to accelerate technology transfer from research to U.S. industry. Author

N91-23064*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
FARMS: THE FLEXIBLE AGRICULTURAL ROBOTICS MANIPULATOR **c37**
Paul S. Gill *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 344-349 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13I

A technology utilization project was established with the Marshall Space Flight Center and the University of Georgia to develop an Earth-based, robotic end effector to process live plant (geranium) material which will improve productivity and efficiency in agricultural systems such as commercial nurseries and greenhouse systems. The aim is to apply this technology to NASA's presence in space, including permanently manned space stations and manned planetary communities requiring large scale food production needs. Author

N91-23065*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Robotic Hardware and Flight Experiments Group.
DIVERSE APPLICATIONS OF ADVANCED MAN-TELEROBOT INTERFACES **c54**
Douglas A. McAffee *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 350-360 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 05H

Advancements in man-machine interfaces and control technologies used in space telerobotics and teleoperators have potential application wherever human operators need to manipulate multi-dimensional spatial relationships. Bilateral six degree-of-freedom position and force cues exchanged between the user and a complex system can broaden and improve the effectiveness of several diverse man-machine interfaces. Author

N91-23066*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
URODYNAMIC PRESSURE SENSOR **c52**
Thomas Moore *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 363-369 (For

primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 14B

A transducer system was developed for measuring the closing pressure profile along the female urethra, which provides up to five sensors within the functional length of the urethra. This new development is an improvement over an earlier measurement method that has a smaller sensor area and was unable to respond to transient events. Three sensors were constructed; one of them was subjected to approximately eight hours of use in a clinical setting during which 576 data points were obtained. The complete instrument system, including the signal conditioning electronics, data acquisition unit, and the computer with its display and printer is described and illustrated. Author

N91-23067*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Center for Space Microelectronics Technology.
ELECTRON TUNNEL SENSOR TECHNOLOGY c35
T. W. Kenny, S. B. Waltman, J. K. Reynolds, and W. J. Kaiser *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 370-381 Sponsored in part by DARPA (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 14B

Researchers designed and constructed a novel electron tunnel sensor which takes advantage of the mechanical properties of micro-machined silicon. For the first time, electrostatic forces are used to control the tunnel electrode separation, thereby avoiding the thermal drift and noise problems associated with piezoelectric actuators. The entire structure is composed of micro-machined silicon single crystals, including a folded cantilever spring and a tip. The application of this sensor to the development of a sensitive accelerometer is described. Author

N91-23068*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PRACTICAL APPROACHES FOR APPLICATION OF RESISTANCE TYPE STRAIN GAGES ON HIGH TEMPERATURE COMPOSITES c35
Thomas C. Moore, Sr. *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 382-391 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 14B

Four major areas of interest with respect to utilizing strain gages on carbon/carbon (with SiC surfaces) and titanium matrix composites are addressed. Strain gage and adhesive combinations on carbon/carbon (C/C) at temperatures from minus 190 C to to 540 C, half-bridge gaging for reducing apparent strain on C/C using Poisson's ratio and bending configurations, a review of the 'field installation' techniques developed for gaging a C/C hypersonic generic elevon, and results of initial strain gaging efforts on titanium matrix composites are discussed. Current research in developing techniques for increasing the maximum temperature for strain gages on carbon/carbon are reviewed. Author

N91-23069*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
AI MASS SPECTROMETERS FOR SPACE SHUTTLE HEALTH MONITORING c35
F. W. Adams *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 392-399 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 14B

The facility Hazardous Gas Detection System (HGDS) at Kennedy Space Center (KSC) is a mass spectrometer based gas analyzer. Two instruments make up the HGDS, which is installed in a prime/backup arrangement, with the option of using both analyzers on the same sample line, or on two different lines simultaneously. It is used for monitoring the Shuttle during fuel loading, countdown, and drainback, if necessary. The use of complex instruments, operated over many shifts, has caused problems in tracking the status of the ground support equipment (GSE) and the vehicle. A requirement for overall system reliability has been a major force in the development of Shuttle GSE, and is the ultimate driver in the choice to pursue artificial intelligence (AI) techniques for Shuttle and Advanced Launch System (ALS) mass spectrometer systems. Shuttle applications of AI are detailed. Author

N91-23070*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
INSTRUMENTATION FOR OPTICAL OCEAN REMOTE SENSING c48
W. E. Esaias *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 400-412 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 08C

Instruments used in ocean color remote sensing algorithm development, validation, and data acquisition which have the potential for further commercial development and marketing are discussed. The Ocean Data Acquisition System (ODAS) is an aircraft-borne radiometer system suitable for light aircraft, which has applications for rapid measurement of chlorophyll pigment concentrations along the flight line. The instrument package includes a three channel radiometer system for upwelling radiance, an infrared temperature sensor, a three-channel downwelling irradiance sensor, and Loran-C navigation. Data are stored on a PC and processed to transects or interpolated 'images' on the ground. The instrument has been in operational use for two and one half years. The accuracy of pigment concentrations from the instrument is quite good, even in complex Chesapeake Bay waters. To help meet the requirement for validation of future satellite missions, a prototype air-deployable drifting buoy for measurement of near-surface upwelled radiance in multiple channnels is undergoing test deployment. The optical drifter burst samples radiance, stores and processes the data, and uses the Argos system as a data link. Studies are underway to explore the limits to useful lifetime with respect to power and fouling. Author

N91-23071*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
MONITORING AND CONTROL OF ATMOSPHERE IN A CLOSED ENVIRONMENT c45
R. Humphries and J. Perry *In* National Aeronautics and Space Administration, Technology 2000, Volume 1 Mar. 1991 p 413-420 (For primary document see N91-23021 14-99)
Avail: NTIS HC/MF A18 CSCL 13B

Applications requiring new technologies for atmosphere monitoring and control in the closed environment and their principal functions aboard the Space Station Freedom are described. Oxygen loop closure, involving the conversion of carbon dioxide to oxygen; carbon dioxide reduction and removal; and monitoring of atmospheric contamination are discussed. The Trace Contaminant Monitor, the Major Constituent Analyzer, the Carbon Dioxide Monitor, and the Particulate Counter Monitor are discussed. Author

N91-23072*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
RESEARCH AND TECHNOLOGY
1990 149 p
(NASA-TM-103759; NAS 1.15:103759) Avail: NTIS HC/MF A07 CSCL 05B

A brief but comprehensive review is given of the technical accomplishments of the NASA Lewis Research Center during the past year. Topics covered include instrumentation and controls technology; internal fluid dynamics; aerospace materials, structures, propulsion, and electronics; space flight systems; cryogenic fluids; Space Station Freedom systems engineering, photovoltaic power module, electrical systems, and operations; and engineering and computational support. Author

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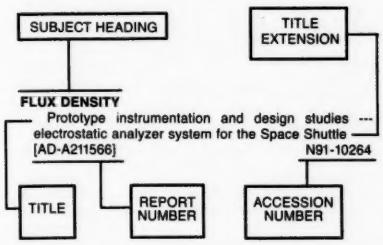

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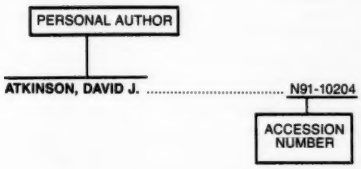

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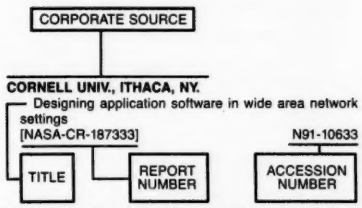

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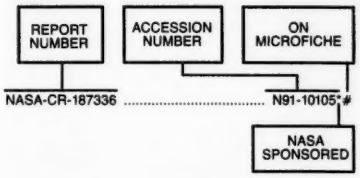

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